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THE YUKON ECONOMY
ITS POTENTIAL FOR GROWTH AND CONTINUITY

VOLUME V   REFERENCE STUDY ON MINERALS

D. Wm. Carr & Associates Ltd.

Ottawa

July, 1968

THE YUKON ECONOMY

ITS POTENTIAL FOR GROWTH AND CONTINUITY

VOLUME V REFERENCE STUDY ON MINERALS

Mineral Industry Study, Yukon Territory

by

W. B. Magyar and Dr. G. C. Monture
Resources Engineering of Canada Limited
Toronto

Background study prepared for D. Wm. Carr & Associates Ltd. as part of the Yukon Economic Studies undertaken for the Department of Indian Affairs and Northern Development and the Government of Yukon Territory.

While authorizing the publication of this study, which has been prepared at their request, D. Wm. Carr & Associates Ltd. do not necessarily accept responsibility for all the statements or opinions that may be found therein.

Ottawa

July, 1968

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RESOURCES
ENGINEERING

TELEPHONE: (416) 925-9541
TELEX: 02-2364
CABLE: RESOURCES

RESOURCES ENGINEERING OF CANADA LIMITED

1047 YONGE STREET, TORONTO 5, CANADA

July 10, 1968

File: 210-00C

Dr. D. W. Carr,
D. W. Carr & Associates Ltd.,
56 Sparks Street,
Ottawa 4, Ontario

Dear Dr. Carr:

We are pleased to submit herewith 20 copies of our report entitled "Mineral Industry Study - Yukon Territory", in fulfilment of our obligation to you with respect to the Yukon Economic Study.

Mr. Magyar and I will be most pleased to review this report with you, and if necessary, to assist you in any discussions that you may have with the Department of Indian Affairs and Northern Development, and the Government of the Yukon Territory.

We were most pleased to be associated with you in this project and enjoyed the execution of this interesting assignment.

Yours very truly,

G C Monture

G. C. Monture,
Special Consultant

WBM/ts

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EXHIBITS*

*The Exhibits are numbered according to Chapter identity and numerical sequence therein, and they are located at the ends of the respective Chapters.

CHAPTER 1

SUMMARY AND CONCLUSIONS

1- Annual Mineral Production

Prior to World War II the mineral production of the Yukon Territory was comprised mainly of gold and silver, and annual production value ranged between three and six million dollars. Exploration activity increased considerably after completion of the Alaska Highway in 1943 and an increase in mining activity occurred in 1947 when the United Keno Hill Mines were brought into production. Improved technology in geophysical and geochemical prospecting led to the reappraisal of many old prospects and workings during the 1950's. Increases in metal prices for copper, lead, zinc, and silver in the mid-1960's resulted in another upsurge in mineral exploration. Favourable mining regulations and tax laws, and Government assistance for basic services, resulted in a rapid expansion of exploration and the current development of three large new mines.

If present conditions and trends continue, the value of production is expected to increase from its current annual level of $14,700,000 to about $50,000,000 by 1970. This increase will result from the new mines of Anvil, Cassiar and New Imperial now under active development. Many other ore bodies are known in the Yukon, but under present conditions they are marginal and most can be expected to remain dormant until conditions change. In the meantime, new development is likely to be confined to higher grade ore deposits from which commercially acceptable concentrates can be produced economically.

Further substantial growth of the mineral industry in the Yukon will depend upon new discoveries and the extent of public and private investments in new services, facilities and other developments. Other important factors are (i) the availability of funds for exploration efforts from industry and government, (ii) the comparative level of profits to be earned by prospectors, developers and mining companies, and (iii) the investment climate as influenced by tax incentives and the laws

and regulations imposed on the mining industry. These factors are inter-related and they are controllable to a large extent. The growth potential will therefore vary over a wide range depending upon the objectives identified as desirable goals and policies. However, if the fullest potential is to be realized, it will be necessary to increase public expenditures substantially as a means of encouraging private investments in exploration and development.

2- Mineral Potential

From a geological point of view, the Yukon Territory is potentially endowed with a wide range and a substantial volume of minerals. The presence of a lead-zinc-silver mineralogical province has been established in the southeast extending from Watson Lake northwards to Ross River and Mayo; this province covers an area that is approximately 400 miles long and 150 miles wide. The Anvil Mine near Ross River with reserves exceeding 60,000,000 tons of ore, is being developed for production by 1969; it seems reasonable to expect that other similarly large deposits will be found within this broad area.

A promising copper-gold belt is centred on Whitehorse and extends nearly 350 miles in an east-west direction from Wolf Lake to Beaver Creek across a 75 mile width. Zinc showings appear frequently at the eastern end of this copper-gold belt whereas nickel showings are common at the western end. Considerable exploration work will be required to determine the commercial potential of this area. Two prospects in this area are under development by Arctic Mining Company and Hudson Bay Explorations. Other prospects are expected to be explored intensively in the near future.

Asbestos showings occur within a narrow area stretching 150 miles in a northwesterly direction from Carmacks to Clinton Creek along the strike of the Tintina Fault. The Clinton Creek Mine at the north end is in commercial production and it reports ore reserves in excess of 25,000,000 tons which are expected to be ample for at least 20 years of production.

Occurrences of coal are common throughout the entire Territory but as yet no serious attempt has been made to exploit these resources on a large scale. At least a dozen showings are known and inferred reserves are stated in the

hundreds of millions of tons. The area around Carmacks has received the most attention to date and it includes three intermittent producers for local heating requirements. However, considerable exploration and research work is needed to prove the usefulness of coal to the economy of the region. The importance of coal lies in its possibilities as a prime source of energy for electric power production in the Yukon and as a reductant for metallurgical processing.

Ion ore occurs near Dawson and at the Crest site along the Snake River. Both are taconite types of concentrating ores but the Crest ore is high in phosphorus content. From a competitive point of view these deposits must be regarded as sub-marginal at present with respect to the recently discovered high grade deposits in Africa and Australia. Moreover, the lack of a cheap means of transportation is also a factor that delays commercial development of these iron ore deposits. If low cost transportation becomes available nearby, or if the feasibility of iron ore mining improves in the Yukon, these deposits may contribute significantly to mineral output. The realization of a cheap means of transportation in the Yukon might imply the construction of a standard-gauge railroad. By coincidence, iron ore appears to be the only commodity conceivable as having the high volume potential needed to justify such a railroad.

There are indications of oil and gas in the north, central and southeastern parts of the Yukon. However, considerable additional exploration work would be required to prove their potential and to justify their development within the next decade. Recent discoveries of petroleum on the Arctic slope of northern Alaska near Prudhoe Bay, about 200 miles west of the Yukon border, might accelerate exploration activity in northern Yukon and in the Beaufort Sea.

Industrial minerals such as barite and gypsum are also known to occur, but they are not commercially exploitable under present conditions.

3- Mining Industry's High Cost Problem

The mining industry in the Yukon is presently faced with high production costs relative to competing areas and it meets these in part by working the high grade ore zones. These

high costs are due to many factors, the most important ones being the following:

a- exploration and development costs tend to be high, perhaps twice the level experienced in Ontario or southern British Columbia. These can be attributed to the difficulty in getting men into the field because of the general remoteness of the Territory, the need to provide basic camps for men, and the limited range of access roads. In addition, the exploration season is shorter, the mountainous terrain restricts the use of light aircraft, and there is generally little local labour available outside of the existing towns.

b- capital costs tend to be higher by about 50% because of the high inward freight on all materials and supplies and the extra costs required to overcome the severe climatic conditions. In addition, there is a scarcity of skilled construction workers, few service facilities, and very limited local sources of supply for construction materials and equipment.

c- the cost of operating a mine in the Yukon is considerably higher than elsewhere because of the high labour turnover and extra hiring and training costs, higher wage demands to meet the higher cost of living, higher electric power rates, higher costs of basic operating materials and supplies and the extra costs of delays and communications due to the isolation of the Territory.

d- working capital requirements for mines in the Yukon are also higher because of the need to provide substantial inventories of spare parts and operating supplies, and the longer time required to receive payment for concentrates shipped over longer distances than is the case elsewhere in Canada.

e- the higher cost of freight on products from the Yukon due to the absence of effective competition among the carriers and the nature of the facilities available. In addition, the longer distances to commercial smelters add extra freight charges.

The above disadvantages are estimated to add overall an average of $30 per ton as extra costs borne by the mining companies on all mine products shipped from the Yukon.

4- Competition for Markets

Because of its location, there is no large market nearby in Canada for the minerals produced in the Yukon - the Territory must compete internationally for the sale of its products. In virtually all cases the mineral products must be transported to tidewater ports where the marketing transactions are effected. The tidewater ports are therefore the real centres of international competition, and the costs to reach such ports have a decided bearing on the ability of Yukon mines to compete for world markets.

The Yukon mining industry is at a severe disadvantage in this respect because the nearest tidewater port is at Skagway, Alaska, and is accessible at only a relatively high cost to the mine operators. Unfortunately, there is no alternative Canadian tidewater port that can be reached at a more reasonable cost to the mining companies. The present freight disadvantage relative to competing mines is estimated to average over $5.00 per ton of mine products on the short rail haul to Skagway, and to average at least another $10.00 per ton on the truckhaul to Whitehorse. The competitive position of the Yukon may therefore be improved substantially only by making available to the local shippers some alternative transport services and alternative tidewater ports.

At the present time external market forces are favourable to the Yukon mining industry. The currently operating mines appear to have long term contracts for their products, and by continuing to exploit the high grade ore zones they can absorb the ordinary fluctuations in prices. Mineral price fluctuations may however, affect exploration activity in the Yukon more than the mining operations, and they also influence the timing of new developments. Consequently the high risk

capital for exploration will generally be directed into countries where prices and costs are most favourable. The Yukon's competitive position on exploration and development capital is strong in terms of markets and prices but it can be enhanced by overcoming the present high cost problems that confront its mining industry.

5- Mineral Production Potential

If the optimum mineral potential of the Yukon is to be realized and developed, then aggressive measures must be taken to improve the competitive position of the mining industry in the Yukon. These measures include the provision of a railway, a tidewater port, electric power generation facilities, townsites, and social amenities. The extent to which government takes the initiative in providing this basic infrastructure can determine the degree of interest taken by industry in new mineral exploration and new mining development in the Yukon. Only by positive long term steps in the above directions will private industry be stimulated to accelerate development of mining operations especially on deposits considered to be marginal in grade under present conditions.

Other key developments to be sought appear to be the initiation of lead-zinc smelting and iron ore mining on a large scale around 1980 to 1985. The value of mineral production could then approach $500,000,000 annually by 1995. Such a scale of production would entail a compounded growth rate of 13% per annum and would require many years of careful planning. Capital expenditures of approximately one billion dollars each by industry and government over the next twenty years would be required to achieve these goals.

6- Lead-Zinc Smelting

Secondary manufacturing in the Yukon is likely to be confined to the smelting of local ores. The possibility of establishing smelting complexes depends on the availability of suitable carbonaceous reductants, electric power at reasonable cost, reasonable freight rates, and a reliable long term source of concentrates. A lead-zinc-silver smelter appears to be a logical consideration for the Yukon because these conditions are potentially available. An independent custom smelter unconnected

with the present metals distribution organizations would not have a good chance of success. The demand for new lead-zinc capacity will justify a new smelting complex somewhere in the world within the next decade; this new smelter could be in the Yukon if the obstacles could be overcome. The availability of suitable carbonaceous reductants in the Yukon is perhaps the aspect that is most uncertain from a technical point of view. Considerable exploration and research will be required on the local coal, oil and natural gas resources to prove their suitability for smelting.

7- Permanent Work Force

The work force in the Yukon tends to be transient, attracting individuals for short periods (a few months to a few years) primarily for the money they can earn. The creation of a more permanent work force can make a major contribution to the mining industry potential. Large scale mining operations will require substantial increases in professional and skilled labour in the Yukon. A ten-fold population increase over the next twenty years is conceivable if the fullest production potential is to be realized. The Canadian mining industry is presently forecasting a shortage of skilled personnel throughout the country. Under these circumstances considerable effort may be required to attract skilled workers to the Yukon and keep them there as contented and permanent residents.

CHAPTER 2

RECOMMENDATIONS

As a result of the observations and analysis of the mineral industry of the Yukon Territory by the study team, the following recommendations are proposed as being the likely measures that can accelerate the effective development of mineral potential in the Yukon:

1. Some long term general objectives must be established by the appropriate Governments involved. These objectives would include the following-

   a- to provide a Canadian tidewater port, capable of berthing large ore carriers, as close to the Yukon as is physically possible, and to have it ready for use by the late 1970's.

   b- to extend a standard-gauge railway into the Yukon from a suitable junction point on the east-west mainline in British Columbia. The railway should also serve the above tide-water port and should be ready for use by the late 1970's.

   c- to provide advance capacity of electric power in the Yukon Territory in substantial amounts and to complete an effective transmission grid by the late 1970's.

   d- to complete a grid of airfields and development roads throughout the entire Yukon Territory by 1975.

   e- to complete the detailed geological survey and mapping of the entire Yukon Territory by 1980.

f- to assure private industry that the incentives and favourable tax treatment will remain available on a long term basis, at least till the year 2000. Policies must be developed to establish fair user charges for the services provided to industry by the various Governments. By this means it may be possible to establish a lead-zinc smelter complex and an iron ore industry in the Yukon.

g- to stimulate and accelerate population growth of the Yukon Territory by providing the basic infrastructure and assisting in community and housing developments.

2. The following measures are recommended for immediate implementation by the appropriate Governments in the near future:

a- to undertake comprehensive feasibility studies and site examinations for the proposed tidewater port - Kitimat or Prince Rupert are possible locations for such a port.

b- to undertake comprehensive feasibility studies and route surveys for the proposed standard guage railway into the Yukon. A possible route could be a northwards extension from Terrace to Telegraph Creek, Cassiar, Watson Lake, Ross River, Mayo and Crest.

c- to proceed with exploration and research on the Yukon coal resources for the purposes of i) verifying the reserves and quality of the known deposits, ii) ascertaining their suitability for thermal-electric power production, and iii) determining their suitability for coking and metallurgical use. Carmacks is a possible site for a large, centrally located thermal electric power plant.

d- to prepare a program for the proposed completion of the comprehensive geological survey of the Yukon Territory; and, to compile and maintain a bibliography of both public and confidential reports on the geology and mineral industry of the Territory.

e- to construct development roads, bridges, and small airfields throughout the territory as illustrated in Exhibit 2-1. This might entail the construction of six new airfields, two thousand miles of new development roads, and six new bridges.

f- to consider the feasibility of establishing a government agency to furnish capital and to act as landlord for housing development in the Yukon.

3. Many suggestions were noted during the study that should provide added stimuli for developing the mineral potential of the Yukon. These were examined and they appear to have sufficient merit for future consideration. Those on which further studies are recommended include the following:

a- the possibilities of establishing central residential communities in the cores of broad mining districts that have potential for development. The mining camps within these districts would then be small satellite communities served by daily air-bus service from the core communities. This concept may reduce the total capital outlays needed for townsite and community development. The core town may be the stabilizing feature that will attract miners and their families and thus reduce the turnover among the labour and professional classes.

b- alternatives to the "Northern Allowance" for Government employees, as for example the provision of an incentive by measures such as a special rebate of income taxes extended to all residents of the Yukon Territory. This rebate could be an amount

b- Cont'd

equivalent to the cost-of-living differential plus a special inducement, and it could be expressed as a percentage (in the order of 25 to 50%) of the taxes paid. An incentive of this nature may be essential to attract the professional and managerial skills that are also vital for implementing an accelerated development program in the territory.

c- to provide electrical heating as the standard form of heating for all residence and commercial establishments throughout the territory. This may be feasible if the feasibility for low-cost electricity from local coal is firmly established.

d- to work diligently towards the establishment of a lead-zinc smelter complex in the Yukon by the late 1970's. In view of the substantial proven ore reserves and energy resources in the territory it may be possible to achieve this goal if the present disadvantages in the Yukon are overcome.

e- to work aggressively towards the establishment of an iron ore mining industry in the Yukon in the 1980's. It may be possible to achieve this goal if the present disadvantages of the Yukon are overcome and if the steel industry is alterted early enough to incorporate the Yukon in its long term planning considerations.

LEGEND

EXISTING ROADS
PROPOSED ROADS
EXISTING AIRFIELDS
PROPOSED AIRFIELDS
CITIES & TOWNS

MINERAL INDUSTRY STUDY
YUKON TERRITORY

PROPOSED ROADS & AIRFIELDS

RESOURCES ENGINEERING OF CANADA LIMITED
CONSULTING ENGINEERS — TORONTO, CANADA

		APPROVED
JMS	WBM	GCM

DATE	SCALE	
JULY 1968	1" = 120 mi.	EXHIBIT 2-1

CHAPTER 3

INTRODUCTION

Purpose and Scope

This study relates to the examination of the mineral industry of the Yukon Territory to ascertain its potential for development and to identify various conditions under which such development might be accelerated. This study is part of a comprehensive economic study of the Yukon which is being undertaken by D. W. Carr & Associates for the Department of Indian Affairs and Northern Development and the Government of the Yukon Territory.

Terms of Reference

The general terms of reference are described in the proposal for an Economic Study of the Yukon Territory submitted to the Department of Indian Affairs and Northern Development by Dr. D. W. Carr in March 1967. Resources Engineering of Canada Limited is acting in the capacity of an associated consultant with particular responsibilities for studying and analyzing the mineral industry.

Acknowledgements

We wish to express our appreciation to the numerous individuals in industry and government who so willingly provided background information and opinions about the Yukon mineral industry. Particular mention must be made of Mr. J. Smith, Commissioner of the Yukon Territory, Dr. T. Wise and Mr. A. D. Oliver, members of the Economics and Resource Development Groups of the Department of Northern Development whose direct assistance in arranging interviews and field trips were invaluable.

CHAPTER 4

YUKON TERRITORY - DESCRIPTION

Location

The Yukon Territory, occupying the northwest corner of Canada, is bounded by Alaska on the west, the Beaufort Sea on the north, the Northwest Territories on the east and British Columbia on the south. All of the Yukon lies between latitude 60° on the south and latitude 70° on the north, and is situated west of the Mackenzie River height-of-land as illustrated in Exhibit 4-1, the map of the Pacific Northwest.

The area of the territory is 207, 076 square miles and is mostly mountainous. The region includes some forest resources in the south, furs and hydro-electric potential in the interior, and mineral resources throughout the entire territory.

Physiography

Several great mountain ranges of the West Cordilleran region with northwest-southeast axes cross the Yukon Territory. The major mountain systems are shown in Exhibit 4-2, and include the St. Elias and Coast Range on the southwest, the Selwyn, Mackenzie and Richardson to the east, the Ogilvie in the centre and the British Mountains to the north. The terrain is rugged and the mountain peaks vary in height considerably from 4, 000 feet in the Selwyn Mountains to over 19, 000 feet in the St. Elias which includes Mount Logan, the highest peak in Canada. Most of the territory lies at least 2, 300 feet above sea level in elevation. The St. Elias and Coast Mountains are formidable barriers that prevent easy overland access to the Pacific Ocean from the Yukon Territory.

Between these mountain ranges lie the major river systems and water basins as shown in Exhibit 4-3. The most important one is the Yukon River which drains approximately 85% of the territory. The rivers also present complications to overland travel within the Yukon; these problems are presently being relieved by a bridge construction program and by the use of ferry services at strategic crossing points.

Climate

The entire territory is within the sub-arctic climatic region. The mean daily winter temperature during January in the south at Whitehorse is -5°F. This mean daily temperature drops to -20°F north of Mayo Landing in Central Yukon. The northern portion of the territory is within the Arctic Circle where temperatures are considerably lower. The lowest recorded temperature in Canada, noted at -81°F, was observed at the recording station in Snag near the southwest corner of the territory. The frost-free period in southern Yukon near Whitehorse averages 55 days; this period becomes considerably shorter as one moves northward in the territory.

The mean daily summer temperatures in July at both Whitehorse and Mayo Landing are 55°F; in the far north this mean temperature drops to 45°F. July is the warmest month and temperatures occasionally reach 90° but the usual daily high is around 75°F.

Precipitation is low and averages around 20 inches per year. Its concentration in the summer, when evaporation is low, permits sufficient moisture for plant life.

Northern Yukon is known as the "Land of the Midnight Sun" during the summer season. At Mayo and Dawson, the daylight hours exceed 20 hours in June; and correspondingly the daylight hours decrease to about 4 hours in December. The short daylight period in winter and the long duration of the winter season which extends from October to April restricts the available time for outdoor activities such as prospecting and mapping.

The northern portion of the territory above latitude 67° is within the continuous permafrost zone. The remainder of the territory is within a discontinuous permafrost zone that decreases in its intensity to the southwest. Only a small part of southern Yukon is outside of the permafrost limits in the Yukon Territory. As a result, special heating and foundation problems must be faced and overcome by construction projects such as mining plants and buildings.

Access

Less than one third of the territory is served by public roads and highways in the Yukon as illustrated in Exhibit 4-4. The only railway access is via the White Pass and Yukon Railway System which owns and operates a narrow-gauge railway between Skagway in Alaska and Whitehorse. This total rail route is approximately 110 miles long and operates in Alaska, British Columbia and the Yukon over this short length. The railway system also holds a franchise to operate a river barge fleet on the Yukon River during the summer months. The barge service was discontinued when truck-haulage on the improved highway systems proved to be a more effective means of transport.

The region is served by the Canadian Pacific Airways with scheduled daily flights from Vancouver and Edmonton to Whitehorse, and by Wien Alaska Airways with scheduled flights from Juneau and Anchorage to Whitehorse. Several smaller private charter airlines also operate within the Yukon, the most important one being the Great Northern Airlines which operates from Whitehorse and Edmonton.

The Beaufort Sea to the north is open to navigation for approximately 2 months during the year from mid-June to mid-August; arctic conditions and ice flows prevent a longer navigation season. There are however no port facilities on the Sea other than at Aklavik and Inuvik near the mouth of the Mackenzie delta in the Northwest Territories; these towns are not connected with the present Yukon roads system.

The Alaska Highway originates at Dawson Creek near the British Columbia-Alberta border some 364 miles northwest from Edmonton. It traverses the southern portion of the Yukon from Mile 776 near Watson Lake, through Whitehorse (Mile 915) and Haines Junction (Mile 1012) to the Alaska-Yukon border near Beaver Creek at Mile 1221. From the border point the road continues on to Fairbanks, Alaska, a distance of 308 miles. Another highway extends northwards from Whitehorse and it passes through Carmacks (Mile 110), to Stewart Crossing (Mile 220) and westard to Dawson City (Mile 333) where it meets the Yukon River. There is no bridge across the Yukon River at Dawson City; however, a ferry service is provided by the Territorial Government during the summer

and an ice road is maintained across the river during the winter. The road continues in a westerly direction for 57 miles to the Alaska border and a 20-mile spur extends to the Clinton Creek mine. At Stewart Crossing a 60-mile spur road extends eastward to the Mayo and Elsa mining camps. A new road from Watson Lake to Ross River was opened recently and this is being extended to Carmacks to serve the new Anvil lead-zinc mine.

The existing road system is shown in Exhibit 4-4. The highways in the Yukon are gravel roads with 22 feet widths and designed to take truck traffic with 45-ton loads. Construction costs for these highways are reported to be about $50,000 per mile. The road system is used extensively by truck transports to haul supplies and concentrates for the mines. The American portion of the Alaska Highway is paved in its entirety; studies are in progress to ascertain the merits of paving the Canadian portion as well as some other northern roads.

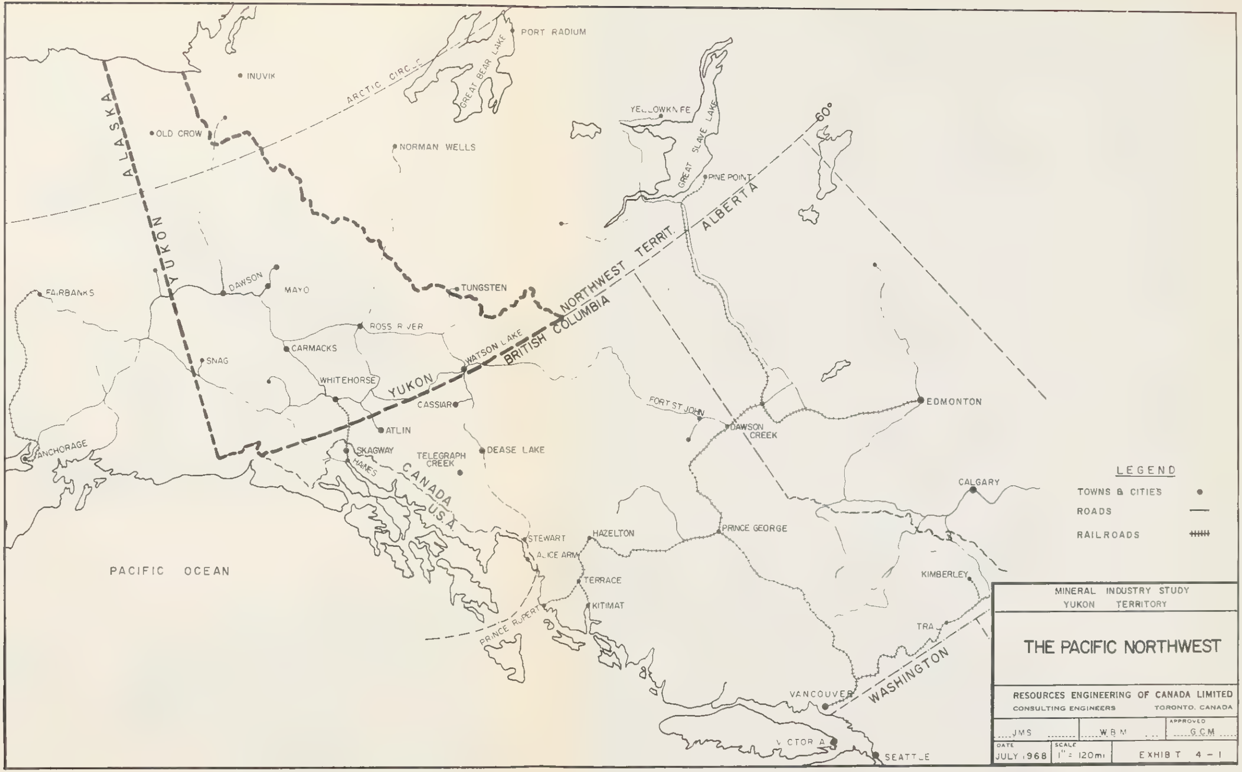
The present tendency of the government road construction programs is towards highways rather than towards lower cost access and development roads which could be constructed for about $20,000 per mile. Approximately $2,500,000 per annum is currently budgeted for new roads and road improvements in the Yukon.

Communications

The Canadian National and Canadian Pacific Telecommunications systems, the Trans-Canada Telephone Network and the Canadian Broadcasting Corporation provide communication services in the Yukon. There is no television service in the territory at the present time but satellite relay stations are contemplated for the near future.

Population

The Dominion Bureau of Statistics reports the population of the Yukon Territory at approximately 15,000 people of whom nearly 7,000 live near Whitehorse. The other major population centres are Watson Lake (1,200), Mayo-Elsa (1,000), and Dawson City (700). Approximately 81% of the population is of European decent; the Indian population is 15%, and the Eskimo population is 1%. Whitehorse serves as the capital city of the territory and houses the government and administration facilities that come under the Department of Indian Affairs and Northern Development.


PORT RADIUM
INUVIK
ARCTIC
GREAT BEAR LAKE
OLD CROW
NORMAN WELLS
GREAT SLAVE LAKE
PINE POINT
60°
ALASKA
YUKON
NORTHWEST TERRIT.
ALBERTA
BRITISH COLUMBIA
FAIRBANKS
DAWSON
MAYO
TUNGSTEN
ROSS
CARMACKS
SNAG
WATSON LAKE
WHITEHORSE
YUKON
CASSIAR
ATLIN
FORT ST JOHN
DAWSON CREEK
EDMONTON
ANCHORAGE
SKAGWAY
HAINES
TELEGRAPH CREEK
DEASE LAKE
CANADA
U.S.A.
LEGEND
TOWNS & CITIES
ROADS
RAILROADS
CALGARY
STEWART
HAZELTON
PRINCE GEORGE
PACIFIC OCEAN
TERRACE
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G.C.M.
DATE
JULY 1968
SCALE
1" = 120mi

LEGEND

A — Arctic Plateau & Plain
B — Yukon Plateau
C — Peel Plateau
D — Mackenzie Plains
E — Liard Plateau
F — Liard Plain & Highland Plateau
G — Eagle Plain

1 — British Mtns
2 — Richardson Mtns
3 — Ogilvie Mtns
4 — Selwyn Mtns
5 — Mackenzie Mtns
6 — Pelly Mtns
7 — St. Elias Mtns
8 — Coast Mtns
9 — Cassiar Mtns

(Mountains are cross hatched)

MINERAL INDUSTRY STUDY
YUKON TERRITORY

THE MAJOR MOUNTAIN SYSTEMS IN THE YUKON

RESOURCES ENGINEERING OF CANADA LIMITED
CONSULTING ENGINEERS TORONTO, CANADA

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JULY 1968	1" = 120 m	EXHIBIT 4 – 2

LEGEND

HEIGHT OF LAND

RIVERS (Flow Indicated)

MINERAL INDUSTRY STUDY
YUKON TERRITORY

THE MAIN RIVERS & WATER BASINS IN THE YUKON

RESOURCES ENGINEERING OF CANADA LIMITED
CONSULTING ENGINEERS TORONTO, CANADA

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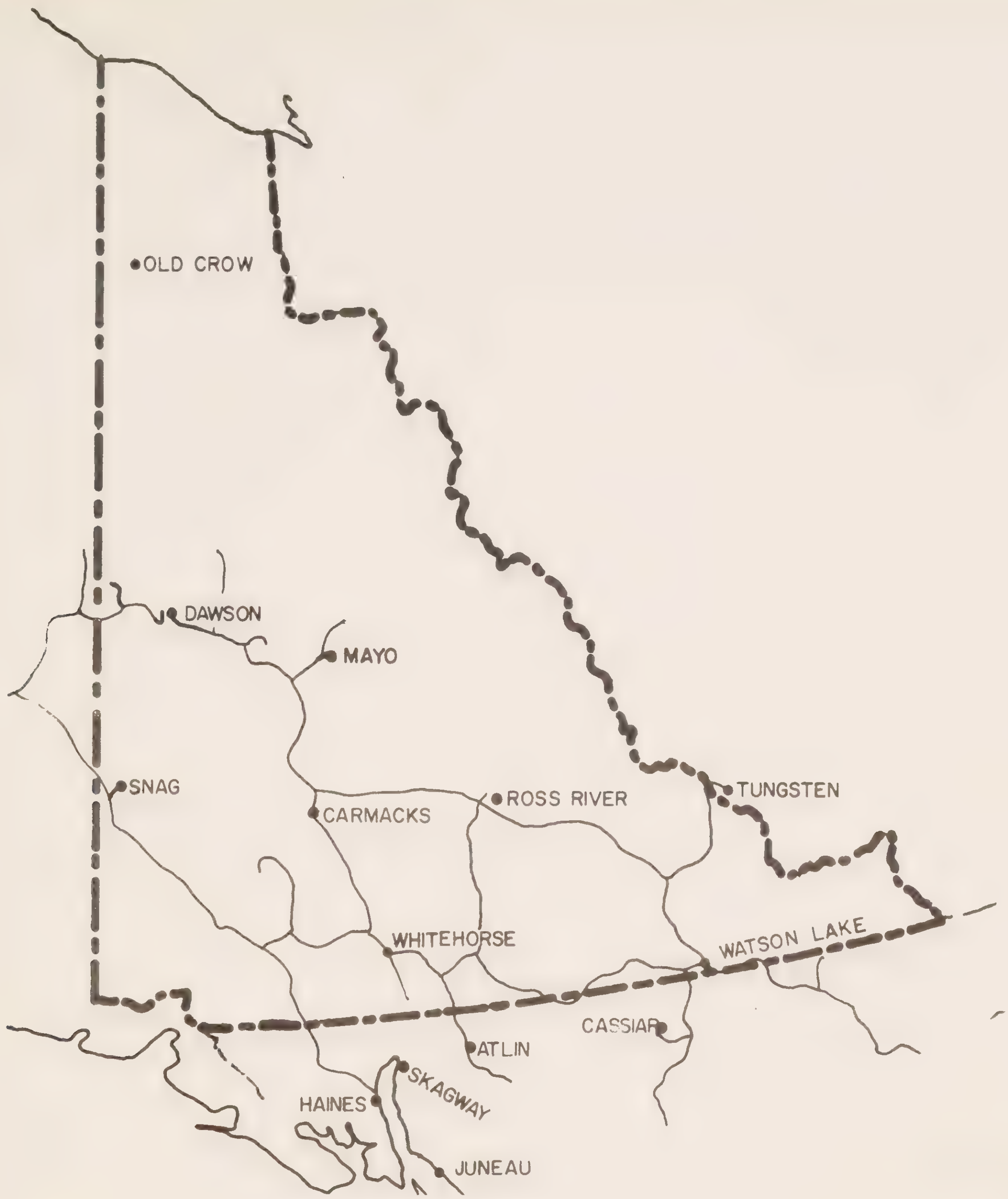
SCALE

EXHIBIT 4 — 3



LEGEND

CITIES & TOWNS •

ROADS & HIGHWAYS ——

MINERAL INDUSTRY STUDY
YUKON TERRITORY

EXISTING ROADS & HIGHWAYS IN THE YUKON

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LEGEND

CITIES & TOWNS	•
ROSS & HIGHWAYS	——

MINERAL INDUSTRY STUDY
YUKON TERRITORY

EXISTING ROADS & HIGHWAYS IN THE YUKON

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CHAPTER 5

DEVELOPMENTS IN ADJACENT REGIONS

Alaska

The mineral industry in the State of Alaska has developed slowly and very little exploration activity is noticeable there today. Approximately a dozen companies are active and the largest mine (currently under active development) will produce only 130,000 tons of copper ore after production commences in 1969. The reasons for this relative inactivity may be the adverse staking laws, rugged terrain which renders exploration costly, and the fact that there are no tax incentives as in Canada. There are, however, several showings of iron ore, tin, copper, gold and silver throughout the State; in addition, several non-metallic minerals have also been discovered among which barite may have commercial significance.

The State has an extensive highway system that connects with those of the Yukon Territory and British Columbia. Several ocean ports are developed - the most important ones are at Anchorage, Skagway, Juneau, Seward and Nome. The general relationship to the Yukon Territory is illustrated in Exhibit 4-1, the Map of the Pacific Northwest. The State owns the Alaska Railroad Co. which operates a standard-gauge railway, between Anchorage and Fairbanks, a distance of about 280 miles. Approximately 250,000 people live in Alaska, and the State is supported to a great extent by an economy based on the U. S. National Defense policy. Juneau, in the Panhandle, is the State Capital; Anchorage is the largest city and has a population of 50,000. The University of Alaska is located in Fairbanks which has a population of 15,000 people excluding those at the U. S. Air Force Base.

There are no large-scale electric power developments in Alaska at the present time. An immense hydroelectric project on the Yukon River at Rampart is being investigated by the State. This site is apparently capable of supporting at least a 2,000,000 KW plant with which the State hopes to attract electro-metallurgical industries to improve

its overall economy. The project is still in the early planning stages and no indications of probable timing are yet available. The Rampart site is approximately 350 miles west of Dawson and about 600 miles northwest of Whitehorse. Approval for such a hydro-electric development has not yet been sought from the Federal Power Commission nor from the International Joint Commission. The Canadian Government's position on this concept has not yet been disclosed, and is not expected to be made public until formal negotiations commence.

Developments in Alaska can be very significant in their effects on the Yukon. If the Rampart Hydro Electric project is built, then mineral activity can be expected throughout Alaska, especially along the Yukon border where asbestos, iron ore and some lead-zinc occur. If major mineral discoveries are made then the eastward extension of the Alaska Railroad to the Yukon border, a distance of 200 miles would be a possible consideration; under such circumstances extensions of the railroad further eastward to Clinton, Dawson and Ross River might also be conceivable. Such a rail route would unquestionably influence the rate of development of railways into the Yukon from other directions.

Northern British Columbia

Northern British Columbia above latitude 55^{o} is relatively uninhabitated and unexplored. Gold and silver from Atlin, and asbestos from Cassiar have been the main minerals of importance produced in northern B. C. Recent exploration activity in the west side of the province is proceeding northwards along the east flank of the Coast Range Mountains. This is an area where immense deposits of copper and molybdenum have been developed such as at Granduc and B. C. Molybdenum. Other types of ore deposits including asbestos, lead, zinc, silver and nickel have also been found in this area. The region, however, lacks road systems and railroad transportation facilities at present; a proposed Stewart to Cassiar highway is currently in the planning stages.

There is no direct overland access from the Province through the Alaska Panhandle to an ocean port north of Stewart because of physiographic and political reasons. Northern B. C. is accessible only by aeroplane as there is no road system into it north of Terrace. Such a road network is presently contemplated in the long range plans of the British Columbia Govern-

ment. The northern British Columbia towns of Atlin and Cassiar are connected by gravel roads with the Yukon road system - these will ultimately connect with the well-developed southern road systems in the Province. The northeast portion of the province is traversed by the Alaska Highway between Dawson Creek and Watson Lake; this highway also provides access into the Peace River area from Fort St. John. Dawson Creek is the northern terminal of the Vancouver - Prince George highway.

Ocean port facilities are being developed at Kitimat and Prince Rupert to accommodate grain, potash and coal exports from Western Canada. These communities are on the Canadian National Railways east-west mainline to Edmonton through Prince George. An ocean port at Stewart is being considered to accommodate the production from the Granduc Mine.

Oil and gas exploration is intensive in Northeastern British Columbia where several fields with production potential have been located. One of the natural gas fields extends into the southeastern tip of the Yukon.

The Peace River power project currently has an installed capacity of 681,000 KW of power; this plant capacity will ultimately be increased to 2,270,000 KW to provide power for the expected industrialization of the north. The Peace River power development is some 600 miles from Whitehorse but it is not connected with the Yukon electric power system. The transmission of electric power from British Columbia into the Yukon is worthy of consideration in view of the high capital costs needed to build hydroelectric power plants in the Yukon.

The economy of the Yukon is dependent considerably on developments in Northern British Columbia. The eastern flank of the Coast Range Mountains is becoming a copper-molybdenum producing centre that is extending northward from Hazelton to Telegraph Creek. This area will undoubtedly be served by a railroad spur from the east-west mainline in the near future. Telegraph Creek is merely 300 miles from Whitehorse and about 400 miles from Watson Lake. The railroad can conceivably be extended to either of these centres and up to Ross River to serve the lead-zinc distrct of the Yukon. Such a line could then be extended to Mayo and Crest with a possible branch to Dawson. The rate at which these developments in British Columbia are constructed will unquestionably influence the interest in railroad construction into and within the Yukon.

Northwest Territories

The main exploration activity in the N. W. T. is centred on oil and gas in the Mackenzie River Basin; and upon lead, zinc, silver and gold in the Great Slave Lake area. The western portion of the Northwest Territories, namely the region west of the Mackenzie River contains only one mine, the Canada Tungsten Mine. The area west of the Mackenzie River is inaccessible and is relatively unexplored for metallic minerals; it has however been subjected to intense oil and gas exploration The only road into this portion of the territory is an access road to the Canada Tungsten Mine from Watson Lake on the Alaska Highway. The Canol Road, a temporary wartime road for a gasoline pipeline from Norman Wells to Whitehorse was abandoned after the war; its reconstruction is now under consideration by the Department of Northern Development.

Recently, there have been discoveries of more tungsten, lead, zinc, and tin along the Selwyn Mountains which form a part of the border between the Yukon and the Northwest Territories.

The most notable recent mining development in the N. W. T. has been the Pine Point Mine a subsidiary of Consolidated Mining and Smelting Co. which commenced production of lead, zinc and silver ores and concentrates in 1964. This mine has shipped concentrates to the parent company's smelter at Trail, B. C. and to the Bunker Hill smelter in Idaho. At December 31, 1966, the company reported ore reserves in the main Pine Point mine and the adjacent Pyramid property at 37, 800, 000 tons grading 2. 9% lead and 6. 8% zinc per ton. The company's original 5, 000 tons per day concentrator is currently being enlarged to 8, 000 tons per day to permit treatment of Pyramid ore in 1969. Contracts were completed in 1966 for shipment of zinc concentrates to Ametalco and the Anaconda companies; and for shipment of lead concentrates to Mitsubishi Cominco Smelting Co. in Japan. The feasibility of smelting concentrates in the N. W. T. has been studied and negative conclusions have been reached. In 1967, this mine alone shipped nearly $90, 000, 000 worth of metals in its concentrates from which it realized $42, 636, 000 in net sales. Other producers shipped gold, tungsten, copper and cadmium valued at an additional $21, 000, 000. A railway line was recently extended to Pine Point from Edmonton to serve the mine.

CHAPTER 6

YUKON MINERAL RESOURCES

Sources of Information

The mineral resources inventory of the Yukon was compiled by the authors of this report primarily from the available data at the Geological Survey of Canada and the Mineral Resources Division of the Department of Energy, Mines and Resources, and from the files and reports of the Department of Indian Affairs and Northern Development. In addition, the operating companies within the Yukon, the British Columbia and Yukon Chambers of Commerce, many private sources, and the press were also consulted for public information. The bibliography lists the reports and articles that were reviewed by the study team.

Considerable information about the Yukon mineral resources and its mineral industry are lodged in the files of the various government departments. Many of these files and reports were brought to the attention of the study team during interviews with interested officers from these departments who remembered relevant documents that they had seen. Considerable difficulties were experienced in locating many of these items and in ascertaining what information is available because a consolidated index and bibliography of the public and the confidential data could not be located. The compilation and periodic updating of such a comprehensive index and bibliography would appear to be a worthy undertaking by the Department of Northern Development. Such records would be most useful in future research projects.

Geology of the Yukon

The Yukon Territory is within the Cordilleran region. Its physical features, early geological work, and general geology were described by H. S. Bostock, R. Mulligan and R. J. W. Douglas in an article entitled "The Cordilleran Region" in Chapter VI of "Geology and Economic Minerals of Canada"

published in 1957 in Ottawa by the Geological Survey, Department of Mines and Technical Surveys. The following is a summary of relevant portions from this paper and the geology of the Yukon is illustrated in Exhibit 6-1.

The western Cordilleran region is one of great geological complexity. It includes sedimentary and volcanic strata which range in age from Proterozoic to Recent during which were noted a number of periods of crustal disturbance accompanied or followed by uplift and erosion. These disturbances varied greatly in intensity, and probably somewhat in time, from place to place; those of late Mesozoic to early Tertiary times are the most prominent. During this interval the folded and faulted strata were invaded extensively by deep-seated granitic bodies, including such batholiths as the Coast, Nelson, Cassiar-Omineca and Mt. Nye, as well as a host of smaller intrusions. The Precambrian, Palaeozoic, and Mesozoic strata now lie for the most part in northwesterly trending folds on the flanks of intrusive bodies such as the Coast and Cassiar-Omineca batholiths. The Tertiary deposits include vast areas of only slightly disturbed volcanic rocks. Widespread mineralization, resulting in many deposits of copper, gold, lead, silver, zinc, and other ores accompanied or closely followed the Mesozoic and early Tertiary intrusions. A few metalliferous deposits, some of them of commercial importance, are thought to be of other ages. Coal seams are found in late Mesozoic and Tertiary strata.

The eastern Cordilleran region is underlain by great thicknesses of Proterozoic, Palaeozoic, Mesozoic and some early Tertiary sedimentary rocks. For the most part these succeed one another without pronounced angular discordance and are generally unaccompanied by plutonic or volcanic rocks. They now form, in great part, lofty mountains of comparatively simple structure. This region also contains extensive coal deposits and possibly important accumulations of petroleum and natural gas.

Known Mineral Occurrences

The most important minerals known to occur in the Yukon are gold, silver, lead, zinc, copper, asbestos, tungsten, cadmium, antimony, nickel, iron ore, coal, gas and oil. The general locations of these occurrences are widespread as shown in Exhibit 6-2. The following checklist is a summary

of these occurrences and their general locations:

Main Minerals	General Location
Antimony ore	Wheaton River, Fish Creek.
Asbestos	Clinton Creek, Klondike River, Quiet Lake, Alsek River, Lake Laberge.
Barite	Frances Lake.
Coal	Carmacks, Old Crow, Clinton Creek, Bonnet Plume Eagle Plateau, Mackenzie Delta, Burwash, Watson Lake, Carcross, Dezadeash Lake.
Copper ore	White River, Whitehorse, Kluane Lake, Donjek River, Bennett Lake, Lake Aishihik, Mt. Nansen, Carmacks, Hoole River, Macmillan Pass, Cantun.
Gold	Klondike District, Firth River, Old Crow, Blow River, Macmillan River, Mayo, White River, Forty Mile River, Carcross, Sixty Mile River.
Iron ore	Crest, Clinton Creek, Bonnet Plume.
Lead-zinc-silver ore	Watson Lake, Mayo-Elsa, Ross River, Frances Lake, Pelly River, Sixty Mile River, Wolf Lake, Castle Mtn. Tombstone Mtn.
Molybdenum ore	Tower Peak, Beaver Creek, Montana Mtn.
Natural gas	Peel Plateau, Eagle Plains, Beaver River.

Main Minerals	General Location
Nickel ore	Mt. Doyle, Wolverine Creek, Burwash, Quill Creek.
Oil	Eagle Plains, Peel Plateau, Beaver River.
Tin ore	Coal River.
Tungsten ore	Ross River, Macmillan Pass Tungsten, Kalzas Lake.

A lead-zinc, silver district has been noted over an area measuring some 150 miles in width and 400 miles in length, extending in a northwesterly direction from Watson Lake through to Frances Lake, the Macmillan Pass, Mayo and into the Ogilvie Mts. This broad district includes the Anvil and United Keno Hill mines as well as many interesting prospects and showings which remain to be explored.

A copper district extends across the southern Yukon from around Wolf Lake westwards to the White River. Copper-zinc showings predominate at the eastern end; whereas copper-nickel, as well as native copper, are known at the western end in the foothills of the St. Elias Mountains. Within the center of this district is located the New Imperial mine, a new copper producer.

Asbestos showings occur along a narrow belt that follows the axis of the Tintina Trench. This zone extends for nearly 400 miles from about Watson Lake in a north-westerly direction to Carmacks, Dawson City and Clinton Creek where Cassiar's new Clinton mine is located.

Coal occurs throughout the Yukon and has been found in twelve widely scattered areas. Mines have operated intermittently at Carmacks and near Dawson City. The coal districts have not been examined in detail and scant information is available on reserves, grade, and suitability for coking and metallurgical uses.

Iron formation in sediments occurs in a narrow belt extending nearly 300 miles eastwards from Clinton Creek

to the Snake River north of the intrusives.

Placer gold is reported in many area throughout the Yukon - the Klondike field near Dawson City is the most noteworthy one. Other areas of interest include the McQuesten River near Mayo and the relatively unexplored Blow River in the far north.

Oil and gas have been the objects of several searches in the Beaver River area near the south-east corner of the Yukon, on the Peele Plateau and in the Eagle Plain in the far north. Discoveries have been made but the commercial importance of the fields have not yet been determined.

Major Deposits and Their Status

The following are brief descriptions of the main mineral occurrences in the Yukon which include the major deposits and those with inferred potential. They are indexed numerically and their approximate locations are noted on Exhibit 6-3.

1- Clinton Creek Asbestos

Asbestos occurs within ultrabasic intrusives over a wide area near Clinton Creek where a large ore deposit is presently being mined by Cassiar Asbestos Corp. Ltd. Ore grade runs about 10% fibre with recoverable values of approximately \$14. 00 per ton of ore. This is a medium length fibre that sells for about \$175. 00 per ton, f. o. b. Vancouver, B. C. Proven reserves are stated to be 25, 000, 000 tons and inferred reserves in the area exceed 50, 000, 000 tons.

2- Coal Creek Iron Ore

Iron ore in the form of magnetite occurs in a pronounced iron formation on the north side of the Yukon River near Coal Creek. Geophysical work, trenching, and sampling have been carried out by the current owners - Selwyn Exploration Ltd. Extensive field exploration and drilling programs are planned for the 1968 season. Ore grade runs in excess of 35% magnetic iron. Inferred reserves, according to the owners, exceed 250, 000, 000 tons and are based on geological interpretations. The principals are currently seeking marketing contracts and financing assistance to bring this property into production around 1975.

3- Klondike Gold

Alluvial gold in unconsolidated conglomeratic beds occurs in the Klondike district near Dawson City in many of the stream beds and river valleys. Yukon Consolidated Gold Corp. Ltd. discontinued its dredging operations in the area in 1966 when gold values were reported to be about 50¢ per cubic yard of material a grade substantially lower than the terminal operating costs of 80¢ per yard published by the company. Some thirteen small private operators using sluice boxes are still active in the general distrct and they report ore grades up to $2.00 per cubic yard. No data is available on ore reserves but estimates unofficially range up to many millions of cubic yards.

4- Mt. Nansen Gold

Gold and silver in veins and fissures occur in the Mt. Nansen and nearby Freegold Mtn. areas near Carmacks. Peso Silver Mines Ltd. is conducting further exploration work on the properties at the present time. Ore reserves of about 200,000 tons containing 0.5 oz. of gold and 20.0 oz. of silver per ton of ore are reported by the owners. The metal content in these reserves at current metal prices would be worth about $60.00 per ton of ore.

5- Tantalus Butte Coal

Coal deposits of Jurassic-Cretaceous age, and low-volatile bituminous in rank, underlie approximately 22 square miles of the Carmacks district. The coal occurs in three seams of minable thickness aggregating 15 to 25 feet. Three mines have operated intermittently providing fuel for local use. The Royal Commission on Coal reported some 53,200,000 tons of possible and probable ore in this area in 1947. The Yukon Coal Company Ltd. operates the Tantalus Butte Mine on a small scale for local heating requirements but it does not divulge reserves as very little exploration has been conducted on this deposit.

6- Carmacks Coal

A portion of the Carmacks coal field is being examined by Anvil Mining Corporation Ltd. but no information has yet been made public. Preliminary feasibility studies

for a mining operation have been completed and the findings suggest that in a small scale operation of 25,000 tons per year coal can be mined by underground methods and delivered to the surface for about $8.00 per ton. Anvil Mining Co. intends to use coal from this mine in 1969 to heat its lead-zinc mining plant and to dry the concentrates before shipment to Whitehorse.

7- Quill Creek Nickel-Copper

Copper-nickel in disseminated and massive sulphides occurs along Quill Creek near Burwash Landing. Hudson Bay Mining and Smelting Co. Ltd. has done extensive underground work on this property and reports reserves of about 738,000 tons grading 2.0% nickel and 1.4% copper which represents about $57.00 in metal values per ton of ore at current metal prices. No production plans have been announced.

8- Quill Creek Nickel

Another deposit near Quill Creek, containing some 542,000 tons, and averaging 1.7% nickel is being explored by Canalask Exploration and Development Co. This grade of ore represents about $32.00 per ton in metal values. No production plans have been announced.

9- Dezadeash Copper

Copper in the form of massive chalcopyrite is found near Lake Dezadeash and is being explored by Johobo Mines Ltd. No details are available.

10- Whitehorse Copper

Copper deposits occur along the contacts between discontinuous bodies of limestone and granitic rocks. New Imperial Mines Ltd. operates an open pit mine in this area and it has completed considerable exploration work in the surrounding area. Ore reserves in excess of 4,500,000 tons are claimed by the company. These are reported to contain 1.2% copper and about $1.00 in precious metals for an average metal content valued at $14.00 per ton of ore. Additional tonnages of similar ores are being proven at several nearby locations.

11- Wheaton Antimony

Antimony in disseminated and massive sulphides was found near Wheaton and was developed by the Yukon Antimony Corporation. Probable reserves of 350,000 tons containing 5% antimony have been reported by the company. This ore would have a current value of $40.00 per ton in place. No production plans have been announced.

12- Montana Mtn. Gold-Silver

Gold and Silver in vein deposits occur on Montana Mtn near Carcross and these are being developed for production by Arctic Mining and Exploration Ltd. Some 200,000 tons of ore containing 1 oz. of gold and about 4 oz. of silver per ton of ore are reported by the company. This grade would represent about $48.00 per ton of ore in metal values less penalties for the arsenic and antimony known to be associated with this complex ore.

13- Faro Lead-Zinc-Silver

Lead-zinc-silver sulphide ores of the replacement type occur in flat lying beds within the sedimentary rocks in this area. The Faro deposit on Anvil Creek near Ross River is being developed for production by Anvil Mining Corp. Ltd. Ore reserves are stated to be in the order of 60,000,000 tons grading 3.4% lead, 5.9% zinc and 1 oz. silver for a total current value of $28.00 per ton of ore. The open pit operation now being readied for production includes approximately 40,000,000 tons of a higher grade ore containing over 4% lead, 6% zinc and over 1 oz. of silver per ton of ore - this grade represents about $34.00 of metal values per ton of ore.

14- Vangorda Lead-Zinc-Silver

Another lead-zinc-silver type of deposit similar to the previous one is at Vangorda Creek near Ross River this was the original discovery in the area. It is now owned by Vangorda Mines Ltd. a subsidiary of Kerr Addison Mines Ltd. This deposit was drilled and estimated to contain some 9,400,000 tons of ore grading 8% combined lead and zinc and having current metal values of about $24.00 per ton of ore. No production plans have been announced.

15- Swim Lake Lead-Zinc-Silver

Another similar lead-zinc-silver deposit was developed by Kerr Addison Mines Ltd. at Swim Lake near Ross River. This deposit is reported to contain about 15,000,000 tons of ore grading 9% combined lead and zinc for a total metal value of about $29.00 per ton of ore. No production plans have been announced.

16- Keno Hill Silver-Lead-Zinc

High grade silver-lead ores in narrow veins within quartzites and greenstones are found around Keno Hill near Elsa where United Keno Hill Mines Ltd. have been in operation for over 20 years. Ore reserves are stated at nearly 350,000 tons containing 32 oz of silver, 6.5% lead and 5.5% zinc which represent current metal values of about $105.00 per ton of ore. A new ore body was recently discovered near the Elsa mill and it is now being prepared for production.

17 - Mt. Haldane Silver-Lead

Another silver-lead deposit at Mt. Haldane near Elsa is being explored by Hecla Mining Co. No information is publicly available on the results to date.

18- Snake River Iron Ore

Iron ore in a thick, uniform sedimentary formation of hematite and jasper was discovered by Crest Explorations Ltd. along the Snake River while exploring for oil and gas. This deposit is exposed for a distance of some 32 miles with thicknesses up to 500 feet. Reserves are estimated in excess of 20,000,000,000 tons grading 43.8% iron and 0.34% phosphorus. Metallurgical tests have been completed and the results indicate that the phosphorus content in concentrates cannot be reduced below 0.07%P by mechanical means. As such, the concentrates are not readily merchantable without prohibitive penalties. Recent metallurgical research employing pre-reduction techniques has demonstrated the production of an acceptable grade of a metallized product containing over 90% iron and less than 0.1% phosphorus.

About 1.4 billion tons of ore are proven in one area alone which would be suitable for open pit mining; no over-

burden removal would be required in this area and a concentration ratio of 2 tons of ore per ton of concentrates containing 66% of iron is indicated. Feasibility studies for ore processing and for possible transportation routes have been completed by the company and development of the property has been deferred until more favourable conditions become apparent.

19- Bear River Iron Ore

An inferred iron formation deposit near the Bear River is currently being explored by Pacific Giant Steel Co. Ltd. Geophysical work has been initiated but no information is yet available.

20- Macmillan Tungsten

A tungsten showing occurs near the Macmillan Pass. The property has not been extensively explored and it is presently dormant. No detailed information is available.

21- Macmillan Lead-Zinc-Silver

A lead-zinc-silver deposit within sediments occurs near Macmillan Pass. This was explored by Hudson Bay Exploration and Development Ltd. who reported 10,400,000 tons of reserves containing 5% zinc and nominal values in lead and silver. This ore would currently represent metal values of about $15.00 to $20.00 per ton of ore. No production plans have been announced.

22- Pelly Lake Copper-Zinc

Copper-zinc-silver occurs in sediments near Pelly Lake and Frances Lake. This deposit is being explored by Atlas Explorations Ltd. who have planned considerable field work and drilling programs for the 1968 season.

23- Fyre Lake Copper-Gold

Copper-silver-gold in a flat-lying replacement body occurs near Fyre Lake and Wolf Lake. This was examined by Atlas Exploration Limited and reserves in the order of 1,000,000

tons averaging 1% copper and nominal values in precious metals are indicated with a total current value of about $14.00 per ton of ore. No production plans have been announced.

24- Hyland River Lead-Zinc

Zinc-lead-silver occurs near Hyland River. A deposit containing over 1,000,000 tons of ore was outlined by American Smelting & Refining Company, and Noranda Mines Ltd. The average grade was reported at 9.5% zinc, 4.9% lead and 5 oz. of silver for an approximate metal values of $54.00 per ton of ore. No production plans have been announced.

Summary of Ore Reserves

A summary of ore reserves in the previously listed 24 known deposits is tabulated in Exhibit 6-4 and these are classified according to the main ore types. The estimated current values shown in this Exhibit represent the value of the contained metal or industrial mineral per ton of ore in place at recent published prices, and before allowances for recovery factors, processing losses and transportation losses.

The most abundant known reserves are those of iron ore, coal, lead-zinc-silver ores, and asbestos. Approximately 200 mineral occurrences representing many types of potential ores are on record but very few of these are yet proven ore deposits. Of this latter group only 6 deposits are being mined at present; at least another 10 deposits have substantial reserves but they are marginal under present conditions. New discoveries are being reported each year, and more major deposits are expected to be developed as long term reserves in the ensuing years

Public information about most of these mineral occurrences and major deposits is sparse. The compilation of a comprehensive inventory of the Yukon mineral resources by the Department of Northern Development is needed to assist in the formulation of policies and guidelines for future development of the territory.

Potential Mining Areas

The pattern of mineral occurrences and ore deposits with proven reserves suggests the presence of twelve potential

mining areas in the Yukon south of latitude 65°, and at least three promising areas in the far north. These potential mining areas are shown in Exhibit 6-3, and in a northward sequence of locations they include the following:

Watson Lake
Wolf Lake
Whitehorse
Frances Lake
Burwash Landing
Ross River
Carmacks
Macmillan Pass
Mayo
Dawson
Clinton Creek
Snake River
Peel Plateau
Eagle Plain
Blow River

A brief summary of each of these areas follows and it includes a list of the producers, major deposits, mineral showings, possible hopes and accessibility for each area:

Watson Lake Area

Producers	- None
Major Deposits	- Hyland Zinc-Lead-Silver (No. 24)
Mineral Showings	- Zinc-Copper, Silver-Lead, Tungsten, Natural gas, Coal
Possible Hopes	- Copper-Zinc, Coking coal, Asbestos, Tin
Exploration Activity	- Very low
Accessibility	- Only the western portion of this area is accessible from the Alaska Highway. A development road eastward from the Ross River Road along latitude 60° 30' would open up some favourable prospecting country for base metals, coal and natural gas. An airfield at the eastern end near the Beaver River would be helpful.

Wolf Lake Area

Producers	- None
Major Deposits	- Fyre Lake Copper-Gold-Silver (No.23)
Mineral Showings	- Silver-Lead, Zinc, Copper
Possible Hopes	- Silver-Lead, Molybdenum, Porphyry copper
Exploration Activity	- Very low
Accessibility	- The south and western portion are on the present highway system but the interior is inaccessible by roads. A development road eastward from Johnson Crossing to the Ross River - Watson Lake Highway would cross favourable prospecting areas.

Whitehorse Area

Producers	- New Imperial Mines (No. 10)
Major Deposits	- Wheaton Antimony (No. 11) - Montana Mountain Gold-Silver (No. 12) now being prepared for production in 1968 by Arctic Mining Co.
Mineral Showings	- Copper, Silver-Lead, Asbestos, Coal, Placer Gold, Lode Gold
Possible Hopes	- Copper, Gold-Silver, Coking coal
Exploration Activity	- Very intense, especially south of Whitehorse
Accessibility	- The area is reasonably well covered by roads. A development road southwards from Carcross towards Skagway would be very desirable.

Frances Lake Area

Producers	- None
Major Deposits	- Pelly Lake Copper-Lead-Zinc-Silver (No. 22)
Mineral Showings	- Copper, Zinc-Copper, Tin, Silver-Lead
Possible Hopes	- Lead-Zinc, Copper-Zinc, Tungsten
Exploration Activity	- Very intense, especially in the south western portion for lead-zinc and copper-zinc.
Accessibility	- The area is well traversed by the Watson Lake - Ross River Highway and the Watson Lake - Cantun Road. An airfield near Frances Lake would be desirable.

Burwash Landing Area

Producers	- None
Major Deposits	- Quill Creek Nickel-Copper (No. 7)
	- Quill Nickel (No. 8)
	- Dezadeash Copper (No. 9)
Mineral Showings	- Molybdenum, Tungsten, Native copper, Placer gold, Asbestos, Gypsum, Coal
Possible Hopes	- Copper-Nickel, Molybdenum
Exploration Activity	- Moderately intense, expecially for nickel and molybdenum
Accessibility	- The Haines Road and the Alaska Highway cross through the center of this area. Development roads southwestwards into the St. Elias Mountains at Haines Junctions, Destruction Bay and Koidern would be desirable; the northeastern extension of these development roads towards Carmacks would also cross favourable prospecting country.

Ross River Area

Producers	- None
Major Deposits	- Anvil Mining Co. Lead-Zinc-Silver (No. 13)this property is being readied for production in 1969
	- Vangorda Lead-Zinc (No. 14)
	- Swim Lake Lead-Zinc (No. 15)
Mineral Showings	- Copper-Zinc, Silver-Lead, Molybdenum, Asbestos, Nickel, Gold
Possible Hopes	- This area contains some of the largest potential ore reserves of Lead-Zinc-Silver in the world. Porphyry type copper ore with molybdenum is also likely to be found in this area.
Exploration Activity	- Very intense throughout the southern portion of this area
Accessibility	- The southern part of the area is very well covered with highways. The immediate restoration of the Canol Road northwards from Ross River to the Macmillan pass would be an invaluable stimulant for extending prospecting activity into a favourable region that is relatively unexplored.

Carmacks Area

Producers	- Yukon Coal Co. (No. 5)
Major Deposits	- Mt. Nansen Gold-Silver (No. 4) This property is being examined for production possibilities by Peso Silver Mines Ltd.
	- Carmacks Coal (No. 6) This property is being considered for production possibilities in 1969
Mineral Showings	- Copper, Silver-Lead, Molybdenum, Tin, Placer Gold, Lode Gold

Possible Hopes	-	This area is likely to be a major coal mining centre in Canada with the mines serving on-site thermal-electric power plants
Exploration Activity	-	Very modest, and is restricted to Copper and Lead-Zinc-Silver. Development work being done on the coal fields is minimal.
Accessibility	-	The eastern half of the area is very well covered with road systems. Development roads south westward to Aishihik would be desirable as would the northern extension of the Canyon-Aishihik Road to Dawson City. The construction of a major commercial airfield at Carmacks warrants serious consideration.

Macmillan Pass Area

Producers	-	None
Major Deposits	-	Flat River Tungsten (No. 20)
	-	Macmillan Zinc-Lead-Silver (No. 21)
Mineral Showings	-	Copper-Tungsten, Lead-Zinc, Barite, Nickel, Copper-Zinc
Possible Hopes	-	Lead-Zinc-Silver and Copper
Exploration Activity	-	Very low
Accessibility	-	The area is inaccessible by roads. Restoration of the Canol Road would be desirable and the construction of an airfield near the Macmillan Pass would also be helpful. A development road northwestwards from Frances Lake to Old Crow would cross a very interesting area that is presently unexplored.

Mayo Area

Producers	- United Keno Hill Mines (No. 16) - Several small placer gold operators
Major Deposits	- Mt. Haldane Silver-Lead (No. 17)
Mineral Showings	- Silver-Lead, Lead-Zinc, Copper, Placer Gold
Possible Hopes	- High grade Silver-Lead, iron ore
Exploration Activity	- Very intense around Elsa-Mayo and along the Hart River. The eastern half of the area is relatively unexplored
Accessibility	- The southwestern portion is covered by roads, the rest of the area is inaccessible. A development road northeastwards from Keno City to the Snake River would be desirable.

Dawson Area

Producers	- About twenty small placer operators on the Klondike goldfields (No. 3)
Major Deposits	- None
Mineral Showings	- Silver-Lead, Antimony, Placer Gold, Coal, Copper-Lead-Zinc, Asbestos
Possible Hopes	- Placer Gold, Silver-Lead
Exploration Activity	- Very modest, and includes Lead-Zinc-Copper exploration to the northeast of Dawson
Accessibility	- The northern half is covered by the existing Yukon Highway system. A development road southwards from Dawson to Aishihik would open up some favourable prospecting areas. A development road on the north side of the Yukon River is also a worthy consideration.

Clinton Creek Area

Producers	- Cassiar Asbestos Corp. (No. 1)
Major Deposits	- Coal Creek Iron Ore (No. 2)
Mineral Showings	- Asbestos, Placer Gold, Silver-Lead, Coal, Lead-Zinc
Possible Hopes	- Asbestos and Iron ore
Exploration Activity	- Moderate
Accessibility	- An east-west highway from Dawson to the Alaska border crosses this area. A north-south development road from Snag to Old Crow would open up some virgin country.

Snake River Area

Producers	- None
Major Deposits	- Crest Iron Ore (No. 18) - Bear River Iron Ore (No. 19)
Mineral Showings	- Copper-Cobalt, Iron ore
Possible Hopes	- Coal, Natural gas, Oil A major iron ore mining industry is conceivable in this area
Exploration Activity	- Very scant
Accessibility	- The area is inaccessible by roads. A development road from Crest to Keno City would be very desirable. Another development road along the south-west border would also be a tremendous assistance to prospecting and mine development - this road could be a part of the proposed Old Crow-Frances Lake Road.

Peel Plateau Area

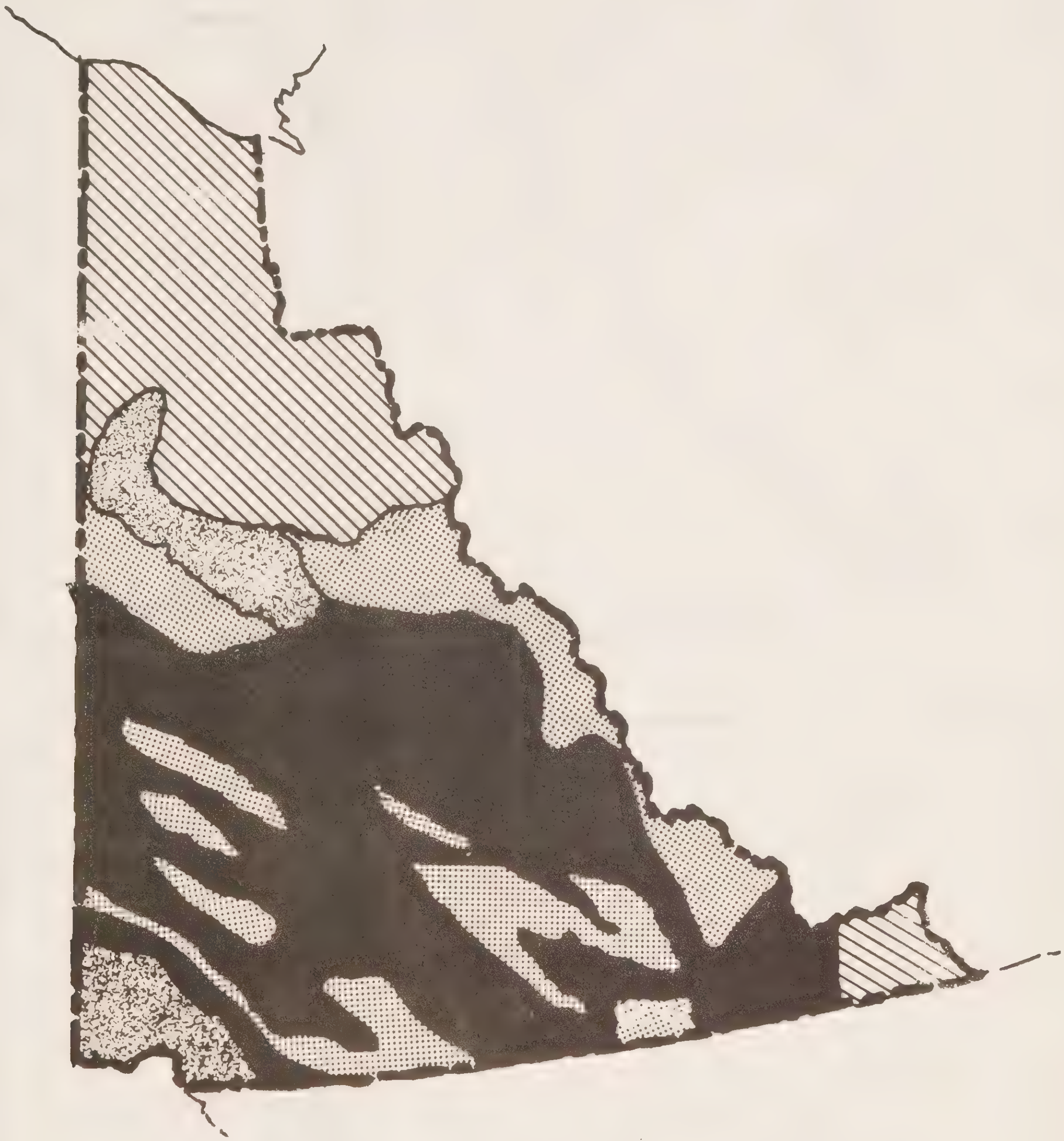
Producers	- None
Major Deposits	- None
Mineral Showings	- Natural Gas
Possible Hopes	- Bituminous coal, anthracite coal, iron ore, Oil and gas
Exploration Activity	- Very scant
Accessibility	- This area is inaccessible by roads. The early extension of the Chapman Lake Road to Fort McPherson would be desirable. An airfield near the junction of the Hart and Peel Rivers is also worthy of consideration.

Eagle Plain Area

Producers	- None
Major Deposits	- None
Mineral Showings	- Oil, Natural gas, Coal, Lead-Zinc
Possible Hopes	- Oil
Exploration Activity	- Very scant
Accessibility	- Presently inaccessible by roads. An airfield at Old Crow would be very desirable.

Blow River Area

Producers	- None
Major Deposits	- None
Mineral Showings	- Placer Gold, Tungsten, Coal
Possible Hopes	- Base metals
Exploration Activity	- None at present
Accessibility	- Presently inaccessible by road; a development road from Old Crow to Shingle Point on the Beaufort Sea would be helpful. An airfield near Shingle Point would also be desirable.



LEGEND

Sedimentary, mountains may contain some intrusives

Sedimentary, Intermontane plains valleys, foothills and plateaus

Intrusives, plateaus, rocks ranging in age from Precambrian to Recent.

Intrusives, mountains may contain minor amounts of sedimentary rocks.

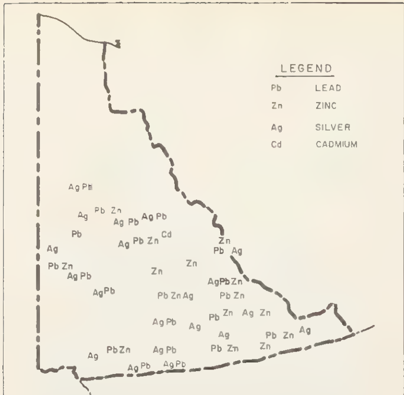
MINERAL INDUSTRY STUDY
YUKON TERRITORY

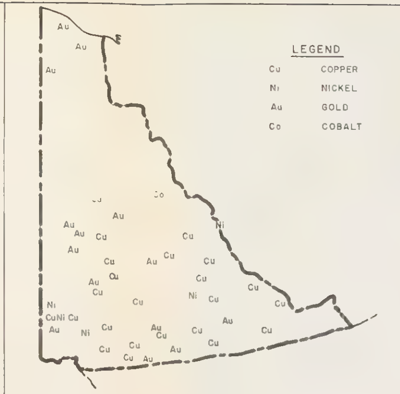
GEOLOGICAL MAP OF THE YUKON

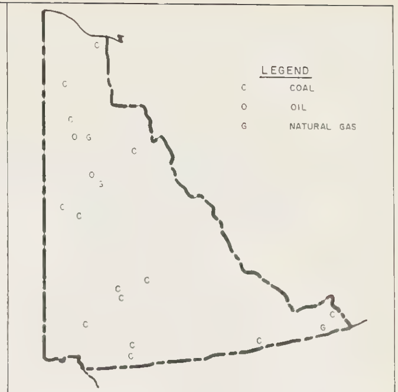
RESOURCES ENGINEERING OF CANADA LIMITED
CONSULTING ENGINEERS TORONTO, CANADA

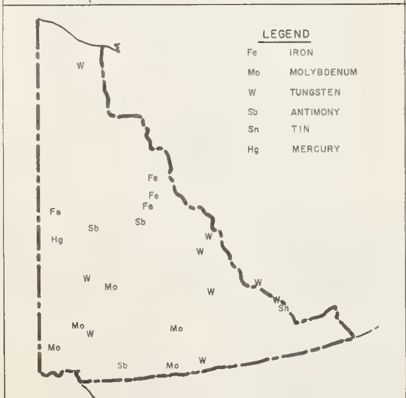
		APPROVED
JMS	WBM	GCM

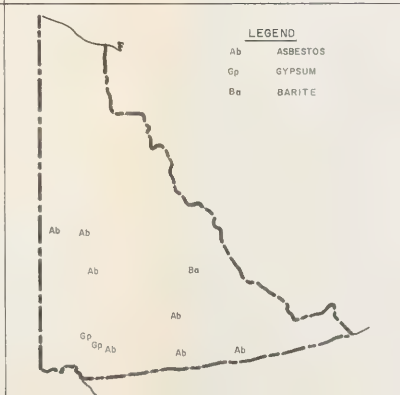
DATE	SCALE	
JULY 1968	1" = 120 mi	EXHIBIT 6 - 1











MINERAL INDUSTRY STUDY
YUKON TERRITORY

MINERAL OCCURRENCES IN THE YUKON

RESOURCES ENGINEERING OF CANADA LIMITED
CONSULTING ENGINEERS TORONTO, CANADA

JMS	WBM	APPROVED GCM
DATE JULY 1968	SCALE 1" = 40mi	EXHIBIT 6-2

LEGEND

POTENTIAL MINING AREAS — DAWSON

MAJOR DEPOSITS — 3

NOTE See exhibit 6-4 for explanation of identity numbers 2

MINERAL INDUSTRY STUDY
YUKON TERRITORY

MAJOR DEPOSITS & POTENTIAL MINING AREAS IN THE YUKON

RESOURCES ENGINEERING OF CANADA LIMITED
CONSULTING ENGINEERS TORONTO, CANADA

		APPROVED
J M S	W B M	G C M
DATE JULY 1968	SCALE 1" = 120 mi	EXHIBIT 6 — 3

EXHIBIT 6-4
SUMMARY OF ORE RESERVES

Ore Type	General Location	Identity Number	Ore Reserves (tons) Proven	Inferred	Ore Grade per ton
Asbestos	Clinton Cr.	1*	25, 000, 000	+ 50, 000, 000	9 %Fibre (R-4, R-5)
Iron Ore	Clinton Cr.	2	-	+ 250, 000, 000	+35% Fe
	Crest	18	1, 400, 000, 000	+20, 000, 000, 000	44% Fe, 0. 34%P
	Crest	19		?	
		Total	1, 400, 000, 000	+20, 250, 000, 000	
Gold	Dawson	3	-	?	Alluvial
	Mayo		-	?	Alluvial
	Burwash		-	?	Alluvial
Tungsten	Macmillan	20	1, 000, 000	?	2. 5% WO_3
Antimony	Whitehorse	11	350, 000	?	5% Sb
Gold & Silver	Carmacks	4	200, 000	?	0. 5oz. Au, 20. 0oz. Ag.
	Whitehorse	12*	200, 000	?	1. 0oz. Au, 4. 0oz. Ag.
		Total	400, 000		

* denotes a deposit that is an operating mine, or is currently being developed into one

EXHIBIT 6-4 Cont'd

Ore Type	General Location	Identity Number	Ore Reserves (tons) Proven	Inferred	Ore Grade per ton
Coal	Carmacks	5*	?	+ 53, 200, 000	Sub-bituminous
	Carmacks	6	?	?	
	Other areas			+ 200, 000, 000	
		Total		+ 253, 200, 000	
Nickel	Burwash	7	700, 000	?	2. 0%Ni, 1. 4%Cu
Copper	Burwash	8	500, 000	?	1. 7% Ni
		Total	1, 200, 000		
Copper	Burwash	9	?	?	?
	Whitehorse	10*	5, 500, 000	+ 10, 000, 000	1. 2%Cu+Au
	Wolf	23	1, 000, 000	?	1. 0%Cu
		Total	6, 500, 000	+ 10, 000, 000	
Lead	Anvil	13*	40, 000, 000	+ 60, 000, 000	3. 4%Pb, 5. 9%Zn, 1. 0 oz. Ag
Zinc	Anvil	14	9, 400, 000	+ 15, 000, 000	8. 0%Pb+Zn
Silver	Anvil	15	15, 000, 000	+ 25, 000, 000	9. 0%Pb+Zn+Ag
	Mayo	16*	350, 000	?	6. 5%Pb, 5. 5%Zn. 32 oz. Ag.
	Mayo	17	?	?	?
	Macmillan	21	10, 400, 000	?	? Pb5. 0%Zn, ? Ag.
	Watson L.	24	1, 000, 000	?	4. 9%Pb 9. 5%Zn, 5oz. Ag.
		Total	76, 150, 000	+ 100, 000, 000	

EXHIBIT 6-4 Cont'd

Ore Type	General Location	Identity Number	Ore Reserves (tons)		Ore Grade per ton
			Proven	Inferred	
Copper Lead Zinc	Frances L.	22	?	?	?

CHAPTER 7

MINERAL INDUSTRY TODAY

Historical Review

Commercial mineral exploration commenced in the Yukon in the late 1800's as a result of various mineral specimens being relayed into civilization by Indians and trappers. Interest in these early days was primarily confined to gold, silver and copper.

The first major development occurred in 1897 when nearly 50,000 prospectors, miners, promoters, and fortune-seekers ventured into the Klondike District near Dawson City in one of the world's great gold rushes. The activities triggered off by this rush spread into many river valleys and led to mineral discoveries at Carcross in the southern Yukon, at Kluane Lake near the St. Elias Mountains, and in the Mayo district. Gold mining predominated until 1920 when gold accounted for 96% of all mineral production. Its importance decreased gradually since then; a sharp decrease in annual gold production from \$1.64 million to \$0.66 million occured in 1967 when the Yukon Consolidated Gold Corporation terminated its dredging operations in the Klondike.

Considerable exploration activity for silver, lead and zinc took place in the Mayo district from 1910 to 1920. In the late 1920's more silver, lead and some copper were found near Whitehorse. The Second World War arrested mineral exploration except for some of the rare minerals containing tungsten and tin which were found in lode and alluvial showings near the southeast along the border with the Northwest Territories.

After the Second World War, considerable prospecting was done along the new highways and roads that had been opened up during the War. These led to many discoveries of mineralized zones containing lead, zinc, silver, copper, nickel, coal and asbestos.

Exploration for oil and gas in the Yukon took place during the mid 1950's and centred upon the Eagle Plain and Peel Plateau in the interior and along the Beaver River in the southeast corner of the territory. No discoveries of commercial importance have yet been found but exploration is still in progress in these areas where gas and oil have been located.

During the late 1950's an immense iron ore deposit was discovered by Crest Exploration Ltd., a wholly owned subsidiary of Standard Oil Company of California, on the Peel River. In the same period, various lead-zinc showings were noted in the southeast area of the Yukon around Ross River. These findings led to the discovery of the large lead-zinc ore body by Dynasty Explorations Ltd. which is currently being developed for production in 1969 by Anvil Mining Corporation Ltd. During this same period the Clinton Creek asbestos deposit of Cassiar Asbestos Corp. Ltd. near Dawson City was developed for production which commenced in late 1967.

The cumulative value of mineral production to date in the Yukon Territory since 1886 is nearly $500, 000, 000. Recent production statistics since 1958 and the total value for the main minerals produced in the territory during the past ten years are shown in Exhibit 7-1, as determined by the Dominion Bureau of Statistics on the basis of metal content in mine shipments and posted metal prices during the respective years.

Cumulative value of gold production to date exceeds $265 millions and accounts for more than one half of the total mineral production to date. Silver exceeds $128 millions and accounts for an additional quarter of total production; the remainder consists largely of lead and zinc. Annual production of minerals ranged between $11. 9 and $15. 2 million during the past ten years and amounted to some $14. 7 millions in 1967.

At the present time silver is the most important mineral, as it accounts for nearly one half of total present annual mineral production. Lead, zinc, asbestos and copper will increase in importance after 1970 when the new mines at Anvil, Clinton Creek and Whitehorse will be in full production.

The Government of Canada has been the prime purchaser of the gold production to date. Lead, zinc and silver have been shipped from the Yukon as concentrates and

have been sold largely to smelters in the U. S. A. and Japan; some concentrates have also been sent intermittently to the Cominco smelter at Trail. The Anvil Mine and New Imperial Mine were financed in part as a result of long term marketing contracts with Japanese smelting companies who have agreed to purchase the concentrates at prevailing world prices. Cassiar's asbestos production is presently sold throughout the world from its Vancouver warehouse.

Risk capital for exploration purposes in the Yukon has come from all over the world, and the list of sources of funds includes the major mining and oil companies of Canada, the United Kingdom, Japan, and the United States of America. Considerable British capital was raised by the Yukon Consolidated Gold Corporation Ltd. who were the dominant company in the Yukon mining industry before the second World War. The mines that are currently in production were financed largely by Canadian interests; namely, the Falconbridge group who control the United Keno Hill Mines Ltd. and the Conwest group, who were instrumental in developing the Cassiar deposits. Canadian groups provided a large part of the financing needs for New Imperial Mines Ltd., and several small development companies. American and Japanese interests assisted in the development of the Anvil Mine.

Current Mining Developments

The Yukon mineral industry is now undergoing extensive changes in its characteristics especially with regard to the long term outlook of the new mines at Ross River, Clinton Creek and Whitehorse. In addition to these, at least a dozen prospects are being intensively explored as more than six of them have proven reserves of ore exceeding 1 million tons. Many known deposits are dormant, however, and they are awaiting more favourable conditions before their economic exploitation can be justified. In the meantime there is a gradual accumulation of new discoveries that are awaiting detailed exploration and development.

The following is a brief description of the mining companies that were either operating mines during 1967, or were in the process of active mine development.

United Keno Hill Mines Ltd.

The company operates several silver-lead-zinc-cadmium underground mines at Elsa and Calumet in the Mayo Mining District. A concentrating mill located at Elsa has a daily capacity of 500 tons of ore but is presently operating at about 250 tons per day on a one-shift basis for five days per week. Annual production during 1967 was valued at $9.1 million in concentrates. The company employed an average of nearly 300 personnel during 1967. Ore reserves after 20 years of operation are being depleted by about 150,000 tons per year at the current annual mining rate. The company is spending over $1,200,000 per year on exploration and development and it recently reported a new discovery near the Elsa mine. Ore reserves in the present operations at the end of 1967 were reported at 250,000 tons containing 38 oz. of silver, 7.2% of lead, and 6.0% zinc with small by product credits for cadmium. The metal content in the reported ore grade at current metal prices is equivalent to about $120.00 per ton of ore in place.

Ore from the various mines is hauled by truck to the central milling and concentration plants in Elsa. Concentrates of lead-silver and zinc-cadmium are produced by differential flotation. The respective concentrates are loaded into special palletized reinforced plywood boxes in 2-ton lots which are loaded onto low-bed 20-ton trucks. The trucks move in convoys and haul the concentrates to the transfer depot in Whitehorse, a distance of 280 miles. There the containers are removed from the trucks and are either stored in the yards or are loaded onto flat cars for rail shipment to Skagway, some 110 miles distant. The trucks return to Elsa usually with a nominal load of mining supplies, fuel oil, food and other items. Specially designed ocean carriers on regular schedules take the containers to Vancouver where the concentrates are decontainerized directly into rail cars for routing to the Asarco lead smelter in St. Helena, Montana and the zinc smelter at Bunker Hill, Idaho. The containers are lined with polyethylene sheets at all times to reduce transportation losses and to alleviate unloading and clean-up problems.

The trucks are owned by the mine but they are operated, and maintained by the joint Transport Divisions of Cassiar Mines and United Keno Hill Mines through Territorial

Supply Company Ltd., a company that is owned 25% by United Keno Hill Mines Ltd., and 75% by Cassiar Asbestos Corporation Ltd. Truck haulage costs to Whitehorse are currently about 6¢ per ton mile or nearly $17.00 per wet ton of concentrates.

Electric power is supplied to the mine by the Northern Canada Power Commission (NCPC) from a nearby small hydro-electric plant having a rated capacity of 6 MW. Present average cost of electric power to the mine is slightly under 2.0¢ per KWH.

The mining personnel and their families live at Elsa which contains 70 housing units, bunk houses, cook house, and commissary. Normal services and facilities including a bank, post office, public schools, churches and first aid facilities are available in Elsa. The district hospital, high school, and government offices are located at Mayo, about 35 miles south of Elsa. Labour turnover is about 5% per month and the company is attempting to create stability by increasing the married proportion of the work force from 25% to 50%.

New Imperial Mines Limited

The company operates a new open-pit copper mine some 10 miles south of Whitehorse in the Whitehorse Mining District. A concentrating mill, employing flotation, has a daily capacity of 2,500 tons of ore. Production commenced in 1967 and the company employs an average of nearly 150 personnel. After one year of operation the ore reserves are reported at 4,500,000 tons of open-pit ore containing 1.2% of copper and $1.00 per ton in precious metals for a total metal content of $15.50 per ton of ore in place. Additional ore reserves exceeding 5,000,000 tons with a grade of 1.5% copper have been reported and are being considered for underground mining. The present open pit mine was brought into production at a capital cost of nearly $8,000,000.

The copper concentrates are loaded into special flat-bed steel containers that are lined with polyethylene; these are lifted onto trucks and hauled a distance of 9 miles to the transfer depot in Whitehorse. From there the containers travel by rail to Skagway and by boat to Vancouver where the containers are emptied, stored in bulk and are routed back to the Yukon. The concentrates are taken every second month by ocean carriers to smelters in Japan.

Electric power is supplied to the mine by the Yukon Electric Co. from a nearby hydro-electric plant owned by the Northern Canada Power Commission and having a rated capacity of 11 MW. The average cost of electric power to the mine is about 1.5¢ per KWH.

The mine derives its work force from the nearby community of Whitehorse and it does not maintain a townsite for its employees. At present the labour turnover varies between 6-10% and is high mostly in the lower job classes.

Cassiar Asbestos Corporation Limited

The company operates a new open-pit asbestos mine at Clinton Creek in the Dawson Mining District; the concentrating mill has a daily capacity of about 4,000 tons of ore and is now capable of producing 60,000 tons of asbestos fibre annually; the mill capacity can be expanded with minimum effort to 80,000 tons. Production of 3,000 tons of asbestos bales were reported in 1967, valued at $513,000. The company presently employs an average of 300 personnel. Ore reserves are reported at about 25,000,000 tons of open pit ore containing about 9% fibre with approximate recoverable values of $14.00 per ton of ore. This mine was brought into production at a capital cost of nearly $26,000,000 including a smaller townsite than was originally planned.

The ore from the open pit mine is hauled by a 5000' long aerial tramway at 300 tons per hour across Clinton Creek to the concentration mill. The final asbestos products are graded, baled, strapped and palletized for loading into trucks which are hauled in convoys a distance of 400 miles to the transfer depot in Whitehorse. There the bales are loaded into containers for movement by train to Skagway and by boat to Vancouver where the bales are unloaded for storage in a central warehouse and are subsequently sold throughout the world at current prices, f.o.b. Vancouver. The company owns a fleet of 68 trucks which are operated by a subsidiary company.

The absence of a bridge across the Yukon River at Dawson causes re-handling and storage problems during the freeze-up and break-up periods when an aerial cable-ferry is used. A ferry service is operated across the river by the Highways Department during the summer months between the above periods.

An ice road is maintained across the river during the winter.

Electric power is generated in a 7 MW company-owned oil-fired thermal plant located in the new townsite some ten miles from the mine. This power plant cost $1.6 million and the average cost of electric power is nearly 4.0¢ per KWH - this high cost results from the very high cost of fuel oil, currently in excess of 30¢ per gallon.

The company is currently experiencing an abnormally high labour turnover rate which it hopes to reduce substantially when the townsite is completed next fall. The townsite will include 7 bunk houses capable of accommodating 220 men, and 37 single family dwellings for the married staff.

Yukon Coal Company Limited

This company is owned by Territorial Supply Company Ltd., a joint venture between Cassiar Asbestos Corp. and United Keno Hill Mines, and it operates the Tantalus Butte Mine near Carmacks in the Whitehorse Mining District. An adit serves the steeply dipping main coal seam. This mine has operated intermittently since 1923; maximum annual production was 14,113 tons in 1954, production was negligible in 1967 and the mine is presently shut down. The coal is of the high-volatible sub-bituminous group and is rated at 12,000 BTU's to the pound and contains 10.0% ash. It is a non-coking type coal that was used exclusively for local heating purposes, primarily at the United Keno Hill Mine. Coal reserves are not fully developed and they are unofficially estimated in excess of 50,000,000 tons. The company is not engaged in exploration and development work on the coal deposits at the present time.

Arctic Mining and Exploration Limited

The company is developing a new silver-gold underground mine on Montana Mtn. near Carcross in the Whitehorse Mining District. A concentrating mill with a daily capacity of 100 tons of ore is under construction and is expected to be in operation in 1968. Ore reserves are reported at 250,000 tons grading 4 oz. of silver and 1 oz. of gold before deductions for recoveries and contaminants of arsenic and antimony. This mine is being brought into production at an estimated capital

cost of $2, 000, 000 and will employ about 100 people.

Anvil Mining Corporation Limited

The company is developing a new lead-zinc-silver open-pit mine on the Faro deposit near Ross River in the Whitehorse Mining District. A concentrating mill with a daily capacity of 5, 500 tons of ore is under construction and is expected to be in operation in 1969. Total mineable open-pit ore reserves are reported in excess of 40, 000, 000 tons containing 4. 0% lead, 6. 0% zinc and about 1 oz. of silver per ton on ore. Separate concentrates of lead-silver, and zinc will be produced by differential flotation with recoveries between 85 and 90%. The metal content of the ore in place at current metal prices is about $34. 00 per ton. Recent exploration work indicates the presence of small high grade zones throughout the deposit. There is a strong possibility that substantial tonnages of reserves suitable for underground mining will also be developed. This mine is being brought into production at an estimated capital cost of about $60, 000, 000.

The respective concentrates will be loaded into special aluminum containers loaded onto trucks and hauled in convoys a distance of 230 miles to the transfer depot in Whitehorse. The containers will then be transferred to railway cars and hauled a distance of 100 miles to a new terminal and bulk loading facility owned by the White Pass Yukon Railway System. This terminal is presently under construction and it will be capable of handling 35, 000 ton ocean vessels. For the next eight years the concentrates will be shipped to smelters in Japan in accordance with a recently completed marketing contract.

Electric power will be supplied to the mine by the Northern Canada Power Commission; the details for a power contract remain to be negotiated. The capacity of the Whitehorse hydro-electric plant will be increased to meet this need and a new transmission line will be extended to the Anvil mine. Heat for the mining plant and for the drying of concentrates will be provided by coal shipped to the mine from Carmacks.

A new and modern community will be developed some 10 miles from the mine site to accommodate the mining personnel and their families. A new road from Ross River to Carmacks is under construction and will be completed in October, 1968.

Yukon Consolidated Gold Corporation Limited

This company terminated its dredging operations in 1966 in the Klondike alluvial gold fields in the Dawson Mining District. In its last year of operation the company produced 34, 031 ounces of fine gold and 7, 675 ounces of silver. The latest reported ore grade was 43¢ per cubic yard and costs in 1966 exceeded that amount. The company has retained some of the gold claims but has mothballed most of its dredges; it also abandoned its hydroelectric power plant near Dawson and salvaged most of the copper in the former power transmission lines to the dredges.

Small Placer Gold Mines

The Geological Survey of Canada reported 22 active small placer mining operations in 1966 as follows:

Mining District	Location of Workings	Number of Operators	Approximate crude gold production (ounces)
Dawson	Klondike	13	8, 637
	Sixty-Mile River	1	
	Kirkman Creek and Stewart River	2	677
Mayo	Haggart Creek and Dublin Gulch	2	1, 017
	Highet Creek and Johnson Creek	2	1, 100
Whitehorse	Kluane Lake	2	322
Other	Miscellaneous areas		297
	Total	22	12, 050

These operators are mostly family units of small syndicated ventures who operate claims on a seasonal basis. They use monitors, bulldozers, sluice boxes and manual means to recover gold during a 4-months season from mid-May to mid-September when sufficient water is available. Their productions provides the local handicrafts industry with gold nuggets for jewellry and ornamental purposes but the bulk is

sold to the Canadian mint. Peak seasonal employment by these small placer operators is about 100 men.

Mapping Status

Throughout the years, the Geological Survey of Canada (GSC) has conducted reconnaissance surveys in Northern Canada; its long-term objective is to map the entire Canadian north including the Yukon Territory.

The latest geological map of the Yukon Territory, Map 1048A, was published by the GSC in 1957. This map, drawn to a scale of 1" to 20 miles, showed less than half of the territory and largely the southwest portion, as being geologically mapped at that time. Subsequent work by the GSC has concentrated on areas where major mineral developments have been taking place; about 35 geological reports have been published since 1957. Detailed maps on a scale of 1 inch to 1 mile are not yet available for the areas of prime interest. Most of the territory south of latitude 64° 30' N has now been covered by aero-magnetic surveys performed by the GSC; these maps, on a scale of 1 inch to 1 mile, are also available to the public.

Exploration Activity

Mineral claims recorded in the Yukon Territory increased from an annual average of 3000 claims per year prior to 1964 to 7, 613 claims in 1965, 17, 938 claims in 1966; and 7, 415 claims in 1967. The locations of recorded claims held in good standing at the end of 1967 are shown in Exhibit 7-2.

Approximately 100 companies are now engaged in mining and they include nearly 50 Canadian companies and 50 major international mining and oil companies. Their annual expenditures are unofficially estimated at five million dollars for prospecting, mapping and drilling. The areas of current interest are in the south half of the Territory (below latitude 64°) at Ross River, Whitehorse and Burwash Landing. North of latitude 64° there is some interest in oil and gas, and in iron ore, but current field programs are not very active. Names of exploration companies that held ground or were active in the Yukon in 1967* are shown in Exhibit 7-3.

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*From Survey of Mines 1967, Financial Post, Toronto

Extent of Processing

All of the mines in the Yukon, with the exception of the alluvial gold mines, practice some form of ore concentration, usually a froth flotation technique. The present practice in the Yukon is the mine and process only those ores from which high grade concentrates can be obtained economically; this criterion is followed owing to high total shipping and handling costs between the mine sites and distant custom smelters that purchase the Yukon concentrates. Under present conditions the lean massive sulphide ores and complex ores are of little commercial interest.

According to its terms of agreement with the Department of Northern Development, Anvil Mining Corporation must examine the feasibility of a local smelter to treat its lead and zinc concentrates; the studies are scheduled to commence after the open pit mine is brought into production. The company's marketing contract with Japanese smelters will expire in 1977 and by that time a decision might be expected on a smelter complex to be located in or near the Yukon. No other firm plans for processing or smelting ores in the Yukon are apparent at this point in time.

Sources of Capital Funds

Senior financing for the recent large mining operations at New Imperial and Anvil were provided by Japanese, American and Canadian participants. Markets for Yukon concentrates are primarily the smelters in Japan, and to a lesser extent those on the U. S. west coast. Financing for the mines has been possible as a result of long term marketing agreements with these smelter interests.

The Toronto-Dominion Bank became the first major Canadian financial institution to participate significantly in a new Canadian northern mining venture. It led a group that includes three U. S. banks (First National City Bank of New York, Bankers Trust Co. of New York, and United California Bank of Los Angeles) in providing $42 million in term loans to Anvil Mining Corporation Ltd; the Toronto-Dominion put up $21 million of this amount at an undisclosed interest rate. Mitsui Mining and Smelting Co. and Toho Zinc Co., both of Japan, have contracted to purchase the Anvil concentrates over an eight year period.

The Toronto-Dominion Bank also provided $2, 750, 000 in a loan to New Imperial Mines Ltd., secured by first mortgage bonds which mature June 30, 1969 and carry 7-3/4% interest. Sumitomo Metal Mining Co. of Japan agreed to loan C$4, 700, 000 of which $1, 600, 000 is convertible at the lender's option into common stock at $1. 30 per share; the loan is secured by 6% first mortgage bonds and is repayable within 5 years from start of production, and not later than December 31, 1972.

Profitability

United Keno Hill Mines Ltd. is the only mine still in operation that has been in continuous production for more than ten years in the Yukon. With the exception of 1966, its net profit after taxes has averaged about $1, 000, 000 per year over the past five years or about $5. 00 per ton of ore mined. Direct production costs were previously reported in the order of $40. 00 per ton of ore but they are now around $60. 00 per ton with the lower volume of production. The other mines in the Yukon are just commencing large scale production and meaningful data on their profitability is not yet available.

Contribution to the Yukon Economy

The value of mineral production in the Yukon has fluctuated during the past 10 years between $12 and $16 million annually and it was $14. 7 million in 1967 as reported by the Dominion Bureau of Statistics. This production level was maintained despite a lower output of gold, silver, zinc and lead which were offset by increases in copper and asbestos.

The new mines of Cassiar, Anvil and New Imperial are expected to add more than $70 million to the value of minerals production in the Yukon when they reach full capacity operations in the mid 1970's. Total mineral production may then be expected to exceed $85 million annually if present conditions and development efforts continue.

A substantial portion of the labour force of the Territory is dependent directly or indirectly on the mining industry. The current mines payroll includes over 1000 personnel; an additional 200 are estimated to be involved in exploration and prospect development, about 300 are engaged in mining plant construction, and several hundred are employed in supporting and service industries.

Electric Power

The Northern Canada Power Commission owns and operates the electrical utility system in the Yukon and it produces electric power in two small hydro installations - one at Whitehorse rated at 11.2 MW* and the other at Mayo rated at 5.2 MW. In addition to these basic installations supplementary electric power is furnished through diesel plants at Dawson, Whitehorse and Clinton Creek. Hydro electric power rates are in excess of $0.015 per KWH to industrial users; domestic rates are in the order of $0.15 per KWH, the thermal electric power production costs are in the order of $0.040 per KWH because of high fuel oil costs of 30¢ per gallon in the interior.

The Yukon is not yet covered by an electric power transmission grid, but one is planned for the distant future. Site surveys on the main tributaries of the Yukon River are underway to estimate the hydro power potential of the province. The largest undeveloped source for hydro power is the Yukon River itself which has a potential of more than 3,500 MW. Capital costs for the construction of small and moderately sized hydro electric installations are estimated at about $650 per KW - this amount is more than three times the equivalent cost in eastern Canada.

Thermal-electric power production from local coal is not presently contemplated by the planning authorities. Preliminary feasibility studies undertaken by the coal mine operators suggest that in a large scale operation coal could be mined and delivered to the surface for some $4.00 per ton provided that ample recoverable reserves can be substantiated. Preliminary calculations carried out in connection with this report suggest that with this cost for coal thermal electric power could be produced for as low as $0.006 per KWH at Carmacks in a 300 MW plant for which capital costs would approximate $250 per KW. Carmacks coal could be the cheapest source of electric power in the Yukon and further work on this concept is warranted.

Water

The Yukon is considered to be an area with a relatively low annual rainfall; however, the stream and river

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*MW is the abbreviation for megawatts, KW is the abbreviation for kilowatts, 1 MW is equal to 1,000 KW.

systems collect the run-off from the mountain ranges and provide an abundant source of water on a year-round basis. These rivers can be controlled to a large extent to assure ample quantities of water for industrial and residential use throughout the territory.

The long winter season and permafrost conditions force special requirements on water supply and sewage treatment systems. Pipelines must be buried more than six feet in the ground and must be heavily insulated and traced with electrical conductors to relieve freezing tendencies. Reliable circulating pumps must also be installed in the systems to keep lines flowing as an additional precaution against freezing. Inspection routines must be rigidly enforced and stand-by maintenance equipment must be provided at all times to cope with possible emergencies.

Communications

Postal service is provided on all scheduled airline flights into the Yukon. One day service is usually available to Vancouver; at least two days are required for the Toronto service.

The rates for telephone service to points within and outside of the Yukon are high and the need for frequent calls to such areas results in substantial extra expenses to the mining companies and local businesses. As a result most companies also use Telex systems extensively for communications.

Transportation Routes and Freight Rates

Commodities move into and out of the Yukon by five main routes; namely,

1. The White Pass and Yukon rail and pipeline route through Skagway,

2. Private trucking along the highway systems via Haines, Alaska,

3. Private trucking along the highway systems via Edmonton, Alta.,

4. The commercial airlines route via Edmonton, Alta., and

5. The commercial airlines route via Vancouver, B. C.

The White Pass and Yukon Railway System and its beneficial owners enjoy a monopoly position on transportation in the Yukon through their control of the railroad, pipelines, bus lines, and the two largest public trucking fleets that operate in the Yukon. The distance from Whitehorse to Vancouver via the White Pass and Yukon Railroad approximates 1000 miles of combined rail and ocean distances and the journey can be completed in 72 hours. In 1966 the published haulage rates on this system were $16.00 a ton for mine concentrates shipped from Whitehorse to Vancouver. Inward rates on machinery, petroleum products, and supplies from Vancouver exceeded $2.75 per cwt. A White Pass trucking subsidiary, Loiselle Transport is, by far, the largest and most active trucking company operating in the Yukon. Representative transportation costs for all modes of travel which were in effect in the Yukon during 1966 are tabulated in Exhibit 7-4.

Freight rates on commodities moving into the Yukon appear to be set by the White Pass and Yukon Route. As a result, it is estimated that approximately 5¢ /lb. is the freight cost passed on to the Yukon consumer on foods, construction materials, clothing, and all other goods in relation to prices at the point of origin.

The main highways in the Yukon are gravel roads with 22' wide road surfaces and capable of withstanding 90,000 lbs. truck loads. Although the road surfaces are maintained in good condition by the Public Works Department of the Yukon Territorial Government, the highways are regarded as hazardous because of unusual dust problems. Tire wear is very high and most experienced travellers carry two spare wheels and 2 extra tires in their trucks as stanard equipment. Truck haulage costs borne by the mining companies exceed 6¢ per ton mile.

Several small airlines operate charter flights throughout the Yukon - the most important of these is Great Northern Airways which serves all of the leading communities in the Yukon and Northwest Territories. Prescribed airfreight and air passenger charges for these carriers are authorized by the Canadian Transport Commission and are published by the Commission. The helicopter and float aircraft find limited use in the Yukon because the country is unusually mountainous and contains very few lakes. Twin engined aircraft, with reliable radio equipment are the preferred ones in the Yukon.

Manpower

The population of the Yukon is very small and is largely concentrated in the Whitehorse area where nearly one half of the total population live. Whitehorse is now the Capital for the territory and is the seat of government and administration. The other communities in the territory exist because of mining potential and tourism. The Dominion Bureau of Statistics reported an experienced labour force of 6, 242 people in 1961 out of a total population of 14, 628. This will grow appreciably in the forthcoming years as a result of the new mines presently under construction.

Housing costs are inherently high in the Yukon because of climatic conditions and the generally high cost for goods and services. A modern bungalow, with 1000 square feet of livable space in a new subdivision near Whitehorse is reported to cost in excess of $25, 000. Speculative housing construction is relatively scarce because of the large proportion of transient workers in the Territory; this situation results in the use of any structure, old or new for housing. The present mine construction boom has added to the complications and most of the towns report critical housing shortages.

The floating work force for construction and mining is a transient one that comes mainly from Vancouver and Edmonton. Labour turnover and hiring costs are consequently high. The mining companies at Clinton Creek, Elsa and Anvil provide subsidized camps for their employees; a daily cost of $8. 00 per man is reported to be the average cost to the mine of providing room and board for which the employee usually pays $3. 00 per day.

The federal government furnishes a northern allowance to its employees resident in the Yukon which amounts to about 20% of their base salary. This allowance is not enjoyed by employees in private industry and it is applicable only to government employees who reside on a permanent basis north of the 60th parallel.

Service Industries

The relatively low levels of industrialization and population throughout the Yukon result in the availability of only minimal supporting services for industry. Such items as warehousing, industrial suppliers, maintenance and repair depots, and specialty fabrication shops are few and inadequate at the present time. As a result mine operators are forced to maintain above normal inventories of spare parts to prevent prolonged shutdowns when breakdowns occur.

Social Services

Schools, hospitals, churches, and recreational facilities are reasonably adequate and are concentrated in the major population centres. The high schools are presently located in Whitehorse where residences are provided for students from the rest of the territory. Scholarships to any university in North America are provided by the local Government to all students who qualify for unviersity entrance.

The major towns contain the service clubs, fraternal organizations, and social clubs usually found in established communities. Shopping facilities are good in Whitehorse which serves as the merchandizing and fashion centre for the territory.

The Annual Sourdough Festival is held in Whitehore during February and it provides a mid-winter break for the local populace. This is an international event which features dog sledding, winter sports, snow shoeing and various gala events.

Dependence of Neighbouring Areas

The Yukon mining camps are islands of activity surrounded by vast uninhabited and unexplored territories within the Yukon itself and in the neighbouring areas of

northern British Columbia, Alaska and the Northwest Territories. The major supply centres for the Yukon at present are Edmonton and Vancouver. The major exit point for mineral products from the Yukon is the port of Skagway, Alaska.

The degree of isolation of the Yukon is bestillustrated by the following observations:

1. The mileage from Edmonton to Whitehorse is about 1500 miles via the Alaska Highway and it takes two tothree days to drive this distance.

2. The commercial flying time via C. P. A. from Vancouver or Edmonton to Whitehorse is presently about 8 hours with at least two short stopovers - a jet service will be inaugurated in late 1968 when travel time will be reduced to about 3 hours.

No agricultural products of commercial significance are grown in the Yukon and consequently, all food is shipped in by truck or rail. There are no manufacturing industries within the territory and consequently all building materials, supplies, clothing, and footwear must be imported from outside of the territory.

Comparisons with Other Canadian Mining Districts

The Yukon offers more potentially fruitful prospecting areas than are to be found in most other areas of equivalent size in North America. A broad diversity of minerals is indicated and their widespread presence is reasonably well established. The main differences with respect to the mining industry elsewhere in Canada are in the following key variables:

1. Electric Power - The electric power cost to the mines varies from \$0. 015 to \$0. 040 per KWH in the Yukon; the higher cost applies to electric power generated from fuel oil. By contrast, the cost of electric power in main mineral centres in Ontario and Quebec are \$0. 006 and \$0. 004 per KWH for large blocks of power.

The significance of the higher energy cost applicable in the Yukon lies in the amount of the annual electric power bill paid by the mines. For example, the Anvil mine will

consume about 80,000,000 KWH per year at full capacity operations; thus with the probable energy rate at $0.015 per KWH, the annual bill would amount to nearly $1,200,000 or approximately $3.30 per ton of concentrate produced. An equivalent mining operation in Ontario at the present time would probably pay only $480,000 annually for electric power or about $1.30 per ton of concentrate. The net disadvantage to this Yukon base metal producer is presently about $2.00 per ton of concentrate.

The Cassiar mine at Clinton Creek is affected to a greater extent because its electric power source is fuel oil. At full capacity operations the mine will consume about 50,000,000 KWH annually. Its annual energy bill at a probable unit cost of $0.038 per KWH would be $1,900,000 or $31.65 per ton of product. In Quebec, an equivalent mining operation would probably pay only $200,000 per year of electric power or about $3.35 per ton of product. The net disadvantage to this Yukon asbestos producer is presently about $28.30 per ton of asbestos bales.

2. Freight Cost - Asbestos bales, transported from Clinton Creek to Vancouver move a distance of approximately 1500 miles; of this total about 390 miles is by truck, 110 miles by railroad and the balance by ocean freighter. The total freight cost on asbestos bales approaches $50.00 per ton for the total trip. By contrast, baled groundwood pulp travelling 250 miles by railroad from Newcastle to Saint John, New Brunswick, and then 3,000 miles by ocean freighter to European ports costs the shipper a total of about $18.00 per ton. The net disadvantage to this Yukon asbestos producer is presently about $30.00 per ton of asbestos bales.

Another example of freight cost disadvantages is that on bulk concentrates. Iron ore concentrates move from Shefferville to Seven Island, Quebec, over 357 miles of rail at a cost to the mine operator of approximately $3.00 per ton. By contrast, the estimated cost of shipping iron ore concentrates from Crest to Skagway a distance of nearly 500 miles by a proposed new railway is about $6.00 per ton. The net disadvantage to this potential producer is about $2.00 per ton, an amount that is not easily absorbed by the normally narrow profit margins on this low priced commodity.

3. Construction Costs - Construction costs on capital work items in the Yukon are considerably higher than in areas below the 60th parallel. The Anvil project, a 5,500 ton/day lead-zinc-silver mine and concentrator, will have cost some $60 million to bring it into production. By contrast, the Texas Gulf Sulphur operation at Timmins in Ontario cost $75 million for a 9000 ton/day copper-zinc operation. Capital works, in the opinion of experienced contractors, generally cost nearly twice as much to construct in the Yukon as below the 60th parallel. This differential is due in part to the unusually higher expenses that must be borne for the transportation of equipment, supplies, and manpower. In addition, there are the costs of providing extra inventories and special skilled labour to cope with emergencies - these would not be substantial costs elsewhere.

4. Exploration Costs - Nearly $1 million of highly risk capital was spent by Anvil Mining Corporation on primary exploration to locate the Faro orebody. An additional $4 million was spent in development drilling, metallurgical testing, and feasibility studies before the decision was reached to proceed with mining plans. By contrast, the Texas Gulf deposit near Timmins in Northern Ontario was found at a probable cost of less than $2.5 million for the equivalent work. Some basic causes for this difference are the shorter working season, the very high cost of aerial transporation for men and supplies, and the high cost of field accommodation for men in exploration work in the Yukon.

Furthermore, a general scarcity of lakes, and the mountainous terrain, prevent a widespread use of light aircraft with floats which are extensively used in other Canadian mining districts. Exploration must therefore be conducted with large aircraft and helicopters as extra expense. There are also fewer development roads and outpost camps in the Yukon than in most other areas in Canada. Consequently the prospectors and explorers must set up outpost camps at considerable cost and they are constantly dependent upon aircraft service for communications and supplies. These disadvantages mean that appreciably less field work can be accomplished in the Yukon for the exploration budget than would be possible elsewhere.

5. <u>Cost of Living for Miners</u> - The main components in the miners' cost of living are the costs of food, shelter, heat and clothing, and personal conveniences. Some typical illustrations of differences in conditions between the Yukon and other Canadian mining camps are in the following:

- fruits, vegetables, and meats are about 30% more costly than in southern Ontario, and about 20% more costly than in Northern Quebec.

- rents are difficult to compare because the available dwellings are quite different across the country. In general, however, about 15% less living space is provided at about the same monthly rental amount.

- the price of fuel oil at 40¢ per gallon is nearly twice that in Sudbury or Northern Quebec. This fact, coupled with the longer winter season in the Yukon, results in a doubling of the annual heating bill as compared with other areas.

- clothing prices appear to be about 10% higher in the Yukon, as noted in mail-order catalogues issued by the large department stores.

- car operating costs are about 50% higher in the Yukon because of higher gasoline prices (70¢ per gallon in Dawson vs 55¢ in Timmins), higher tire wear and tire costs (7,000 miles per tire costing \$45.00 vs 12,000 miles per equivalent tire costing \$35.00 in Sudbury), according to unofficial estimates of Yukon residents

- medical and dental services and facilities are available primarily in Whitehorse and the basic fees are about 20% higher than in Vancouver. The cost of getting to Whitehorse and staying there for treatment is an extra consideration for miners and their families. For treatment and care by specialists, the patient would have to fly to Vansouver or Edmonton. Similar circumstances confront the miner in northern Manitoba and in the Quebec-Labrador iron ore camps.

- vacation expenses for the Yukon miner are higher because he has to travel over longer distances to reach the popular vacation grounds. The extra

travelling time also tends to shorten the available time at the vacation destination.

Mining Laws and Regulations

The mining laws and regulations pertaining to the Yukon are administered by the Department of Indian Affairs and Northern Development through its main administration and service staff in Ottawa. Some divisions are resident in the Yukon, - namely, the Mine Recorders Office in each of the four mining districts (Whitehorse, Watson Lake, Mayo and Dawson), and the Mine Inspector's office at Whitehorse.

The laws and regulations are similar to the Provincial laws affecting the Canadian mining industry in the 10 provinces. The appropriate laws and regulations are described in a recent book entitled "digest to Canadian Mineral Laws" by E. C. Hodgson, Mineral Resources Division, Department of Energy, Mines and Resources Cat. No. M38-5/13 1967. The following brief notes are excerpts from the above book that relate to mineral industry in the Yukon.

The duties, powers and functions of the Minister of Indian Affairs and Northern Development relate to:

- the Northwest Territories and the Yukon Territory and their resources and affairs;
- Indian affairs;
- Eskimo affairs:
- National parks.

The Minister and the department exercise powers in the disposition of mineral rights and control over conservation, operating practices, mining taxation and royalties with respect to the Northwest Territories and the Yukon Territory comparable to the power exercised by the government of each of the provinces within the boundaries of each province.

The Minister of Indian Affairs and Northern Development is also responsible for the administration of the following acts:

- Northern Canada Power Commission Act, R. S. Ch. 196

- Dominion Water Power Act. R. S. Ch. 189

- National Parks Act, R. S. Ch. 189

- Land Titles Act, R. S. Ch. 162

- Northwest Territories Act, R. S. Ch. 331

- Yukon Act, 1952-63, Ch. 53

- Part III of Canada Land Surveys Act. R. S. Ch. 26

The Resources and Economic Development Branch of the Department administers the following acts and regulations:

- Public Lands Grants Act, R. S. C. 1952 Ch. 224 amended by 1959 Ch. 52

- Territorial Lands Act. R. S. C. 1952 amended by 1955 Ch. 17 and 1957 Ch. 36

  : Canada Mining Regulations, P. C. 1961-325 and amended by P. C. 1962-968; P. C. 1963-1711

  : Canada Oil and Gas Land Regulations P. C. 1961-797 amended by P. C. 1963-408 and P. C. 1964-1614

  : Territorial Dredging Regulations, P. C. 1954-1920

  : Territorial Coal Regulations, P. C. 1954-1979 amended by 1965-1431

  : Territorial Quarrying Regulations, P. C. 1957-424

: Territorial Lands Regulations, P. C. 1960-1771

: Canada Oil and Gas Drilling and Production Regulations, P. C. 1961-12

- Yukon Quartz Mining Act, R. S. 1952, Ch. 217

- Yukon Placer Mining Act, R. S. 1952, Ch. 216

- Mining Safety Ordinance,
  : Yukon Territory, R. O. Y. T. 1958, Ch. 75,
  : Mining Safety Rules

- Blasting Ordinance Yukon Territory,
  : R. O. T. Y. 1958, Ch. 10,
  : Blasting Rules

- Regulations Governing Accident Prevention in the Yukon Territory, Order 1963-1

- : Prospector's Assistance Program, P. C. 1966-1474

The Indian Affairs Branch of the department is responsible for the administration of the following Acts and Regulations:

- Indian Act, 1951
  : Indian Mining Regulations, P. C. 1961-371
  : Indian Oil and Gas Regulations, P. C. 1966-1271

Incentives and Taxation

Various incentives have been available through the Department of Indian Affairs and Northern Development to encourage prospecting in the Yukon and to assist in development work. The incentives are described in the Canada Gazette, Part II Volume 100 and pertain to the Northern Mineral Exploration Assistance Regulations (P. C. 1966-1641).

The Prospectors' Assistance Regulations (P. C. 1966-1474) provide prospectors with non-reimbursable grants up to $900 per year for mineral exploration in the Yukon; sixty thousand dollars per year is available under this programe.

Seventy-four prospectors were accepted as eligible for grants under this program in 1967.

The Northern Mineral Exploration Assistance Regulations (P. C. 1966-1641) provide a 40% grant towards exploration costs on projects approved and undertaken by a Canadian company. This grant becomes a loan repayable over a period of ten years if the exploration program results in commercial mineral production. Fifteen companies qualified for assistance under the program and a total of more than $1,250,000 was allotted to them in the 1967-1968 fiscal year.

The Department provides capital grants in varying amounts for townsite development, development roads, mine access roads, tote roads, electric power installation, permanent air strips, and other facilities. These programs include the following:

- Northern Roads Program - An amount of nearly $9,000,000 per year is available to meet usual transportation requirements in the entire North, and especially those needed for resource development. The Government bears 100% of the cost of these roads. A part of the Northern Roads Program provides for access roads to mine sites from main roads. The Government bears two-thirds of the cost of these access roads and the company bears the remainder.

- Tote Road Assistance Program - This is available to individuals, groups, and companies for minimum standard access roads. A sum of $100,000 is provided every year for each Territory, and up to 50% of the cost of the road is borne by the Government. Over 44 applicants received such assistance in 1967.

- Permanent Air Strips Program - The Government shares up to 50% of the cost of building permanent airstrips associated with resource development or exploration projects in the North. Several such airstrips have been built in the Yukon on a cost sharing basis between private industry and Government.

Incentives presently offered to Canadian companies that operate mines in the Yukon include the following:

- A three year exemption from federal income taxes is available as of the day when commercial production starts - this feature is commonly known as the 3-year tax holiday.

- Exploration, research and development expenses are fully deductible from income before taxes in the year when such expenses were incurred.

- Pre-production expenses for exploration and development may be capitalized and amortized against future income.

- Losses may be carried forward for up to five successive years and may be applied against future income.

- A depletion allowance of 33-1/3% of profits before taxes is available.

Income taxes are levied against earned income from mineral production in Canada. The income tax rate builds up rapidly to a maximum of 52% of taxable income as determined by the Income Tax Act. There are no taxes levied in Canada on capital gains nor on ore reserves.

An annual royalty is payable on the value of the output of a mine. The royalty rate starts at 3% and builds up slowly to a maximum of 6% on annual profits up to $10 million, and on the excess above $10 million there is a proportional increase of 1% for each additional 5 million dollars, as determined by regulations in the Yukon Quartz Mining Act.

The 11% Federal Sales Tax is currently applicable to all building materials sold in the Yukon; mining machinery, however, is excluded from this tax. There is no Territorial Sales Tax levied at the present time.

A recently imposed Diesel Fuel Tax of 11¢ per gallon is collected by the Territorial Government on all sales

of diesel fuel except that used for heating purposes and electric power generation. This tax is causing hardship to the open pit mining operators and to the placer gold operators because it applies to diesel fuel used in off-highway equipment such as bulldozers, graders, ore-hauling trucks, pumps and heavy construction machinery.

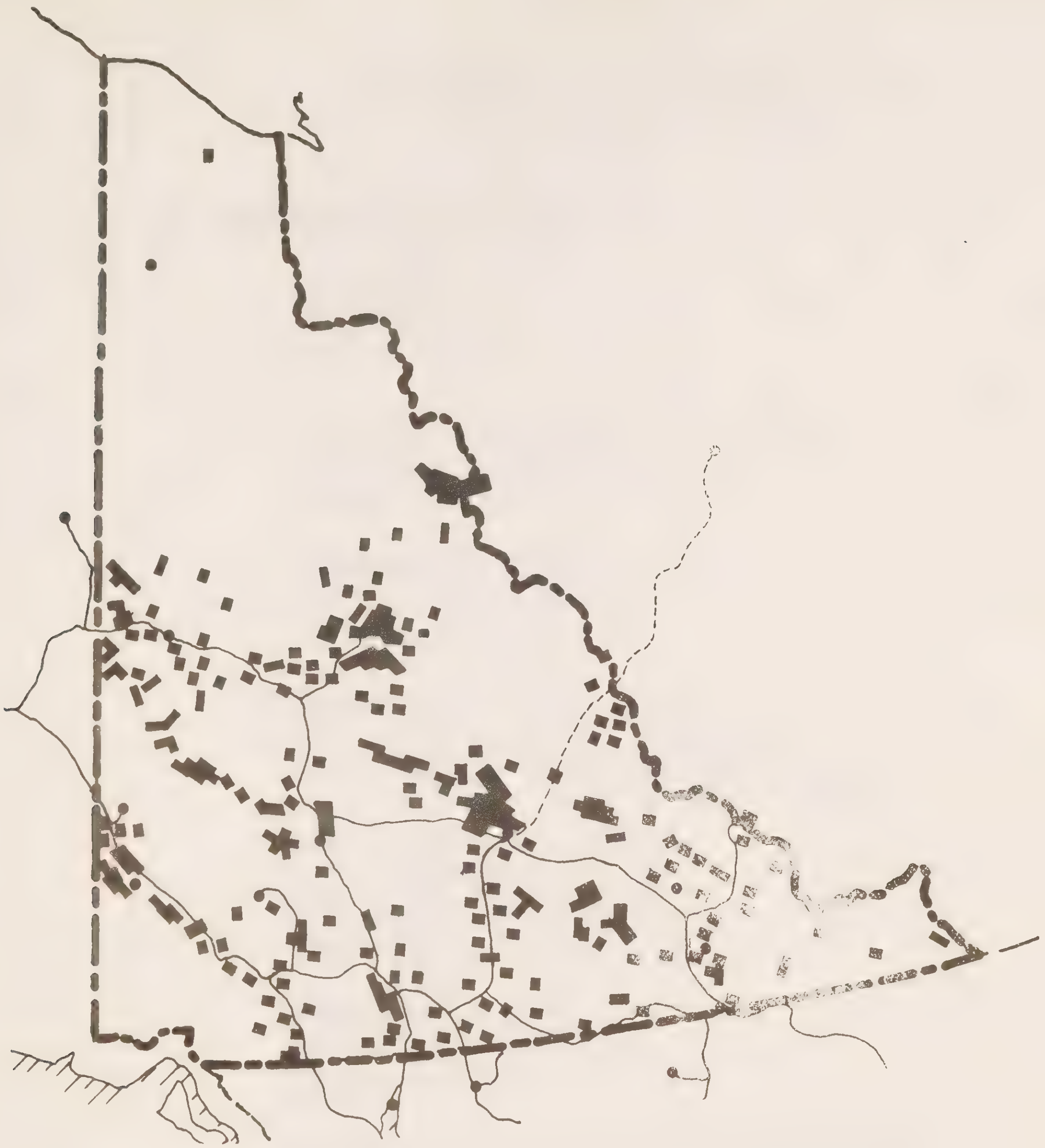
EXHIBIT 7-1

YUKON MINERAL PRODUCTION CHART 1958 TO 1967*

YUKON TERRITORY		1958	1959	1960	1961	1962	1963	1964	1965	1966	1967(a)	Cumulative Total (b)
Gold............	$	2,301,975	2,247,847	2,652,004	2,371,494	2,050,255	2,084,215	2,183,611	1,698,975	1,639,103	659,644	265,072,668(c)
ounces		67,745	66,960	78,115	66,878	54,211	57,844	45,031	43,466	43,466	17,474	
Silver..........	$	5,569,348	6,192,556	6,416,956	6,538,897	7,551,814	8,450,755	7,894,196	6,462,393	5,868,217	6,468,370	128,014,994
ounces		6,415,560	7,054,632	7,217,361	6,937,036	6,482,244	6,106,037	5,638,712	4,615,995	4,194,580	3,769,533	
Lead.	$	2,449,920	2,290,960	2,166,638	1,712,198	1,615,980	1,867,647	2,744,235	2,766,953	2,386,684	2,092,164	55,276,395
pounds		21,566,194	21,592,456	20,286,871	16,769,815	16,290,125	16,978,607	20,418,415	17,851,309	15,975,125	14,801,171	
Copper.	$	---------	--------	---------	257,098	132,990	---------	---------	---------	---------	3,496,395	6,598,178
pounds		---------	---------	---------	880,773	429,000	---------	---------	---------	---------	7,350,000	
Coal....	$	56,379	55,200	97,156	114,221	115,198	123,675	98,150	85,626	46,390	21,000	2,572,341
tons		4,344	3,879	6,470	7,703	7,649	8,231	7,229	8,801	5,670	3,000	
Zinc............	$	1,688,811	1,621,375	1,789,287	1,528,100	1,438,554	1,514,520	1,855,512	2,000,396	1,729,027	1,299,214	33,663,481
pounds		15,522,159	13,246,532	13,402,899	12,137,418	11,888,876	11,850,706	13,094,653	13,247,653	11,450,510	8,825,492	
Cadmium........	$	244,323	181,440	206,604	228,296	231,328	326,124	428,399	386,192	306,336	150,284	5,336,182
pounds		160,739	141,750	145,496	142,685	134,493	135,885	132,222	138,918	118,735	53,673	
Asbestos.........	$	---------	---------	---------	---------	---------	---------	---------	---------	---------	513,000	513,000
tons		---------	---------	---------	---------	---------	---------	---------	---------	---------	3,000	
Total	$	12,310,756	12,592,378	13,328,645	12,750,304	13,136,119	14,366,936	15,204,103	13,400,535	11,975,757	14,700,071	497,047,239

(a) Preliminary figures (b) Cumulative totals - 1932 to December 31, 1967 (c) Cumulative Totals - 1886 to December 31, 1966

* Source: Department of Indian Affairs and Northern Development



LEGEND

CLAIM LOCATION ■

ROADS ——

MINERAL INDUSTRY STUDY
YUKON TERRITORY

RECORDED CLAIMS AT END OF 1967

RESOURCES ENGINEERING OF CANADA LIMITED
CONSULTING ENGINEERS TORONTO, CANADA

		APPROVED
JMS	WBM	GCM

DATE	SCALE	
JULY 1968	1" = 120 mi	EXHIBIT 7 — 2

EXHIBIT 7-3

EXPLORATION COMPANIES ACTIVE
IN THE YUKON in 1967

A - CANADIAN COMPANIES*

Anvil Mining Corp. Ltd.
523 W. 6th St.
Los Angeles, Calif.

Arctic Mining and Exploration Ltd.
1130, 355 Burrard St.
Vancouver, B. C.

Bankeno Mines Ltd.
600, 250 University Ave.
Toronto, Ontario

Brown McDade Mines Ltd.
420-475 Howe St. Vancouver, B. C.
2402, 44 King St. W. Toronto, Ontario

Canadian Baranca Mines
c/o E. Koblanski,
519, 602 W. Hastings St.
Vancouver 2, B. C.

Casino Silver Mines Ltd.
100 W. Pender St.
Vancouver, B. C.

Canada Tungsten Mining Corporation Ltd.
225, 12 Richmond St.
Toronto, Ontario

Central McQuesten Mines Ltd.
420, 475 Howe St.
Vancouver 1, B. C.

* Source: Survey of Mines 1967, The Financial Post, Toronto, Ontario

Comstock Keno Mines Ltd.
702, 220 Bay St.
Toronto, Ontario

Continental Consolidated Mines Ltd.
201, 535 Howe St.
Vancouver, B. C.

Crest Exploration Ltd.
329A, Sixth Ave. S. W.
Calgary, Alta.

Discovery Mines Ltd.
Suite 1011,
2200 Yonge St.
Toronto 12, Ontario

Duncan Ladue Mines Ltd.
420, 475 Howe St.
Vancouver 1, B. C.

Dynacore Explorations Ltd.
1404, 302 Bay St.
Toronto, Ontario

Dynasty Explorations Ltd.
330, 355 Burrard St.
Vancouver, B. C.

Flagstone Mines Ltd.
809, 525 Seymour St.
Vancouver, B. C.

Golden Gate Explorations Ltd.
714 West Hastings St.
Vancouver, B. C.

Great Yukon Mines Ltd.
Main Floor,
165 University Ave.
Toronto, Ontario

Green Valley Mines Ltd.
507, 55 York St.
Toronto, Ontario

Jaye Explorations Ltd.
1503, 330 Bay St.
Toronto, Ontario

Ketza River Mines Ltd.
1001, 85 Richmond St. W.
Toronto, Ontario

Klondike Lode Gold Mines Ltd.
617, 837 W. Hastings St.
Vancouver, B. C.

Logjam Silver Mines Ltd.
400, 112 King St. W.
Toronto, Ontario

Matt Berry Mines Ltd.
801, 347 Bay St.
Toronto 1, Ontario

Mayo Silver Mines Ltd.
309, 535 Howe St.
Vancouver, B. C.

Mount Keno Mines Ltd.
Rm. 702, 220 Bay Street,
Toronto, Ontario

Mount Nansen Mines Ltd.
420, 475 Howe St.
Vancouver, B. C.

Native Minerals Ltd.
1328, 7A St. N. W.
Calgary, Alta.

New Imperial Mines Ltd.
1022, 85 Richmond St. W.
Toronto, Ontario

Northlake Mines Ltd.
Suite 220, 890W. Pender St.
Vancouver, B. C.

Pacific Giant Steel Ores Ltd.
205 Main St.
Whitehorse, Yukon

Parliament Mines Ltd.
302, 121 Richmond St. W.
Toronto, Ontario

Peso Carmacks Gold Mines Ltd.
420-475 Howe St.
Vancouver, B. C.

Peso Silver Mines Ltd.
420 Stock Exchange Bldg.
475 Howe St.
Vancouver 1, B. C.

Redstone Mines Ltd.
1000, 217 Bay St.
Toronto, Ontario

Rio Plata Silver Mines Ltd.
420, 475 Howe St.
Vancouver B. C.

Riviera Mines Ltd.
450, 890 W. Pender St.
Vancouver 1, B. C.

Rodstrom Yellowknife Mines Ltd.
409, 612 View St.
Victoria, B. C.

Silver Key Mines Ltd.
Suite 801, 347 Bay St.
Toronto, Ontario

Silver Titan Mines Ltd.
330, 355 Burrard St.
Vancouver, B. C.

Tay River Mines Ltd.
808, 602 W. Hastings St.
Vancouver, B. C.

The Yukon Consolidated Gold Corp. Ltd.
410 Marine Bldg.
355 Burrard St.
Vancouver 1, B. C.

Tintina Silver Mines Ltd.
Rm. 1001,
85 Richmond St. W.
Toronto, Ontario

United Keno Hill Mines Ltd.
21st Floor, 7 King St. E.
Toronto, Ontario

Vangorda Mines Ltd.
1600, 44 King St. W.
Toronto, Ontario

Venus Mines Ltd.
440, 890 West Pender St.
Vancouver, B. C.

Western Flintstone Mines Ltd.
1128, 736 Granville St.
Vancouver 2, B. C.

B - FOREIGN COMPANIES*

American Metal Climax
American Smelting and Refining Co.
Anaconda American Brass
Arrow Inter-America Corp.
Cyprus Mines Corporation
Hanna Mining Co.
Hecla Mining Co.
Standard Oil of California
Union Carbide Corporation
United States Smelting, Refining & Mining Co.
Utah Construction & Mining Co.

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* Source: The Northern Miner "1968 Exploration Year" issue of March 7, 1968, Toronto, Ontario

EXHIBIT 7-4

REPRESENTATIVE TRANSPORTATION COSTS FOR YUKON TERRITORY, 1966*

RAIL AND BOAT (container ship every 2 weeks)

Ore and concentrates - Whitehorse to North Vancouver
Commodity rate on 30,000 lb. carloads

Lead or zinc concentrates............	$16.00 per ton
Asbestos fibre......................	17.00 per ton

Mining equipment and associated supplies - North Vancouver to Whitehorse - Commodity rate on 10,000 lb. carloads.

Machinery..........................	$2.75 per cwt.
Petroleum products..................	3.15 per cwt.
Drilling mud, building materials.......	2.90 per cwt.

TRUCK

Basic rates, Whitehorse from Edmonton and Vancouver

Pounds....................	100	5,000	10,000
From Edmonton (dollars per 100 lb).........	6.90	5.50	5.35
From Vancouver (dollars per 100 lb).........	7.71	6.70	6.30

(Commodity rates in effect for many items)
(Backhaul rates considerably less)

BUS - (3 times per week, daily in the summer)

Express rates, Whitehorse from Edmonton and Vancouver

Pounds...........	1-2	2-10	10-20	40-50	90-100
From Edmonton dollars.........	2.05	2.55	3.40	6.40	11.35
From Vancouver dollars.........	2.65	2.85	4.00	7.85	14.20

*Reproduced from "The Mineral Industry of Yukon Territory and Southwestern District of Mackenzie, 1966" by D. C. Findlay, Paper 67-40, Geological Survey of Canada, Department of Mines, Energy and Resources, pp. 3-4.

AIR - (daily)

Air express and air freight, Whitehorse from Edmonton and Vancouver

	Edmonton to Whitehorse	Vancouver to Whitehorse
Air express		
minimum	$ 4.00	$ 4.00
dollars per pound	.43	.49
Air freight		
minimum.	5.25	5.25
dollars per pound.	.21	.21
dollars per 100 pounds. . . .	18.00	18.00

CHARTER AIRCRAFT

Type	Rate per Hour	Rate per Mile
Fixed wing		
Cessna.	$65.00	$0.55
Beaver.	80.00	0.80
Helicopter		
Bell 47G-2.	110.00 (fuel and oil included)	
Bell 47G-31.	135.00 (fuel and oil included)	
Hiller 12E.	135.00 (fuel and oil included) (rate per mile not applicable)	

CHAPTER 8

MINERAL MARKETS AND PRICES

World Production Statistics

The production statistics for Canada and the free world were examined for all minerals that are important or could be important for the Yukon economy, namely:

- Asbestos
- Coal
- Copper
- Gold
- Iron Ore
- Lead
- Molybdenum
- Nickel
- Silver
- Zinc
- Petroleum
- Natural Gas

The sources for this information were the Canada Year Book and various minerals surveys which are listed in the Bibliography.

The following discussions and salient statistics for each mineral show Canadian production from 1950 to 1967, world production statistics, and price history to the extent publicly available. World reserves of major ores are noted wherever information was available. Projections of growth trends and prices were based on the authors' interpretation of current trends.

Mineral	-	Asbestos (Salient statistics are in Exhibit 8-1)
Uses	-	Long fibres (groups 1, 2 & 3) for fireproof cloth, yarn, brake linings. Medium fibres (groups 4, 5 & 6) for shingles, siding, wallboard, paper. Short fibres (group 7) for boiler and roofing cements and tiles and insulation.
World Production	-	3, 200, 000 tons in 1963. Canada, South Africa and Rhodesia are the main producers in the West - Russia in the East.
Canadian Production	-	1, 500, 000 tons in 1966 - most in the Eastern Townships of Quebec. Canada is the world's leading producer, its share of world production has declined from 67% to 40% since 1945.
Major Consumers	-	In 1963 the USA consumed 1, 600, 000 tons supplied primarily from Canada.
Processing Centres	-	Concentration of ores, sorting fibres, and baling at mine site. Fabrication into manufactured products is usually done in the consuming centres. All major cities are likely fabrication centres.

Prices Feb. 1968 -

Gp3 (AC)	Gp4 (AS)	Gp5 (AY)	
345.00	200.00	126.00	per ton of baled fibre, f.o.b. North Vancouver

Outlook	-	Trends will follow closely those of industrial production and building construction. Commercial synthesis is being investigated but it is doubtful that it will succeed in becoming a serious competitor to the natural fibre.

Project Consumption & Prices	-	World demand has doubled in past 10 years. Growth rate of 5% per annum is expected for next 25 years when world production may be around 12,000,000 tons annually. Prices will follow the economy and could increase sharply in 10 years if depleted reserves are not replaced.
World Reserves	-	Generally stated at 100,000,000 tons, sufficient for next 20 years. These are mostly in Canada, South Africa, Russia and China. Australia could become an important future source. The Yukon reserves can be an important world supply.
New Mine Production Requirement	-	Approximately 200,000 tons of new fibre production capacity must be developed each year to meet growth requirements for world demand.

Mineral	-	Coal (Salient statistics are in Exhibit 8-2)
Uses	-	Energy source for thermal electric power, reductant for smelting processes, for heating purposes.
World Production	-	3,000,000,000 tons in 1964. Main producers are the U. S. A.
Canadian Production	-	11,300,000 tons in 1966 - a decrease from 19,100,000 tons in 1950. Primarily in Nova Scotia and British Columbia.
Major Consumers	-	All industrialized nations.
Processing Centres	-	Waste is usually separated from the coal by mechanical means at the mine site and a sized product is shipped to the consuming centres for use.
Prices Feb. 1968	-	Variable with Btu content and haulage distance to the consuming centres. Generally \$4.00 per ton at mine site.
Outlook	-	Thermal power plants have been locating adjacent to coal mines because of rising freight rates and technological improvements in electric power transmission. Competition from uranium, oil and hydro limits growth potential as prime energy source.
Projected Consumption & Prices	-	Demand is expected to grow at less than world population, around 1.2% per annum to 4,000,000,000 tons per year in 1990; prices will probably increase at same rate.
World Reserves	-	Generally estimated at more than 5,000,000,000,000 tons, sufficient for over 100 years. Widespread throughout the world Yukon reserves of 250,000,000 tons are useful for local purposes only.

Mineral	-	Copper (Salient statistics are in Exhibit 8-3)
Uses	-	The metal is widely used because of its particular physical properties for electrical applications, construction materials, and in specialty alloys.
World Production	-	10,800,000,000 lbs in 1965. Major producers are the U. S. A., Chile, Rhodesia, Canada Belgian Congo, Peru, Australia and Japan.
Canadian Production	-	1,000,000,000 lbs in 1966: maintained at about 9.5% of world production since 1955.
Major Consumers	-	The U. S. A., U. K., West Germany, Japan France, Italy and Scandinavia.
Processing Centres	-	Ores are processed into concentrates at the mine site. Smelters are generally located in major mining districts. Refineries are usually at cheap power sources. Manufacturing facilities are in the consuming centres.
Prices Feb. 1968	-	51¢ per lb. delivered f. o. b.
Outlook	-	Intense competition is expected from aluminum and other materials.
Projected Consumption & Prices	-	Growth at 2% per annum to 18,000,000,000, lbs. in 1990. Canadian production at 1,800,000,000 lbs in 1990. Prices will probably increase at 2% per annum. Prime markets will be the underdeveloped and emerging nations in Asia and South America.
World	-	About 250,000,000 tons, sufficient for about 40 years. Canadian reserves are about 9,000,000 tons throughout the country. The Yukon can be an interesting long term centre catering to the Pacific region. Approximately 600,000 tons of new concentrates (with 25% copper) production capacity must be developed each year to meet growth requirements for world demand.

Mineral	-	<u>Gold</u> (Salient statistics are in Exhibit 8-4)
Uses	-	Currency, jewellery and ornamentation, some as an industrial material.
World Production	-	48,500,000 fine oz. in 1966 - primarily in South Africa, Canada and the U. S. A.
Canadian Production	-	3,300,000 fine oz. in 1966 - largely as a byproduct from base metal operations.
Major Consumers	-	The governments of the world
Processing Centres	-	Free gold ores are concentrated and usually reduced to a bullion at the mine site. By-product gold from base metals is reduced to bullion at the smelters. Refineries are usually located at Government owned mints.
Prices Feb. 1968	-	\$35.00 U. S. or \$38.05 Can. per fine oz.
Outlook	-	Survival of the gold mining industry is a paramount problem in view of its internationally fixed price (constant since 1934) and rising production costs. Low grade mines will not be able to survive without financial assistance.
Projected Consumption & Prices	-	Growth at 2.0% per year to 78,000,000 oz. in 1990 - related to the base metals industry. Prices will probably increase during the next decade due to international pressures arising from the producing nations. Canadian production will follow the 2% growth rate.
World Reserves	-	Generally stated at about 1,000,000,000 oz - sufficient for about 30 years.

Mineral	-	Iron Ore (Salient statistics are in Exhibit 8-5)
Uses	-	Iron and steel, and alloys in construction materials.
World Production	-	640,000,000 long tons in 1966 in 59 countries. Main producers are the U.S.A., U.S.S.R., France, Canada, Sweden, Brazil, Venezuela, India and Libera, Morocco, Australia.
Canadian Production	-	40,500,000 long tons in 1966 - mostly in Quebec - Labrador. Share of world market has increased rapidly to about 10%.
Major Consumers	-	The industrialized nations - U.S.A., Japan, Western Europe.
Processing Centres	-	Except for the higher grade ores (60-65% Fe), the ore is concentrated, and probably pelletized at the mine sites. Smelting and refining are done where reductants and energy are cheap, and are close to the steel consuming centres.
Prices Feb. 1968	-	$10.55 U.S. per long ton, for 51.5% iron content, delivered to lower lake ports. Pellets containing 63.0% iron content are listed at $15.88 U.S. per long ton.
Outlook	-	Iron will continue to be a basic construction material due to its low cost, strength, and wide uses. High grade natural ores (+60% Fe) are being found in many parts of the world. Pre-reduction to sinter and pig iron is being considered at mine sites where low cost reductants and energy are available.
Projected Consumption & Prices	-	Growth at about 2.0% per annum to about 680,000,000 million tons by 1990. Canada will follow world growth, and prices will probably remain constant due to intensive international competition.

Iron Ore (Cont'd)

World Reserves	-	Enormous reserves are known throughout the world. The magnitude is in the order of 200,000,000,000 tons, which would be sufficient for more than 300 years. The Yukon reserves are not competitive under the presently high production cost conditions prevalent in the territory.
New Mine Production Requirements	-	Approximately 12,000,000 tons of new pellet or high grade ore (+60% iron) production capacity must be developed each year to meet growth requirements for world demand.

Mineral	-	Lead (Salient statistics are in Exhibit 8-[illegible])
Uses	-	Mostly in batteries, tetraethyl fluids, electrical apparatus, ammunition, piping and type metal, and pigments.
World Production	-	About 6,286,000,000 lbs. in 1966. The main producers are Australia, U.S.S.R., U.S.A., Mexico, Canada, China and Bulgaria.
Canadian Production	-	598,000,000 lbs. in 1966 about 9% of World production. Mines are located throughout the country.
Major Consumers	-	Smelters in Europe, U.S.A., Australia, Mexico, Canada and Japan.
Processing Centres	-	Ore is concentrated at the mine site. Smelters and refineries are usually located in the heart of major ore producing districts. Fabrication is done in the major population centres.
Prices Feb. 1968	-	14.0¢ per lb. delivered f.o.b.
Outlook	-	Growth is closely related to automotive industry which consumes more than 50% of all lead in the U.S.A.
Projected Consumption & Prices	-	At about 2.5% per annum to world total of 11,000,000,000 lbs in 1990. Canadian production will be about 1,300,000,000 lbs. Prices will follow at 2.5% per annum.
World Reserves	-	Some 50,000,000,000 tons, sufficient for about 20 years, in widely scattered areas. Yukon is an important centre with long-term production potential.

Lead (Cont'd)

New Mine Production Requirement	-	Approximately 180,000 tons of new concentrate (70% lead) production capacity must be developed each year to meet growth requirements for world demand.

Mineral	-	<u>Molybdenum</u> (Salient statictics are in Exhibit 8-7)
Uses	-	In alloys with steel.
World Production	-	91, 450, 000 lbs. in 1963, mostly in the U. S. A.
Canadian Production	-	Increased to 21, 500, 000 lbs. in 1966 from 834, 000 lbs. in 1963 due to new producers in British Columbia.
Major Consumers	-	The steel producers.
Processing Centres	-	Ore is concentrated at the mine site. Further processing is a specialized art and is conducted mainly in the U. S. A. and Europe.
Prices Feb. 1968	-	$1. 62 per lb. of contained Mo in ores concentrated to 54% molybdenum content.
Outlook	-	Demand will grow faster than for steel because of innovations in the uses of specialty alloys and because of its increasing use in steel.
Projected Consumption & Prices	-	Growth rate at about 3. 5% per annum to 216, 000, 000 lbs. by 1990. Canadian production could grow at 6% per annum to 91, 000, 000 lbs. by 1990. Prices will increase at about 3. 5% per annum.
World Reserves	-	About 30 years' reserves are generally claimed, mostly in Chile, the U. S. A. and Canada. Northern B. C. could be the world's leading producer in the long term.
New Mine Production Requirement	-	Approximately 5, 000 tons of new concentrate (54% molybdenum) production capacity must be developed each year to meet growth requirements for world demand.

Mineral	-	<u>Nickel</u> (Salient statistics are in Exhibit 8-7)
Uses	-	As an alloying component for specialty and stainless steel.
World Production	-	950,000,000 lbs in 1966, mostly in Canada.
Canadian Production	-	468,000,000 lbs. in 1966 - mostly from Sudbury, Ont. and Thompson, Man.
Major Consumers	-	The steel producing nations - primarily U.S.A., Japan, U.K., Germany.
Processing Centres	-	Ores are concentrated at the mine site. Smelters are usually located within the major mining districts. Refineries are generally located near cheap power and market centres. Fabrication is usually done in the consuming centres.
Prices Feb. 1968	-	Electrolytic at $1.015 per lb. in carload lots, f.o.b. Port Colborne.
Outlook	-	Sulphide ores in North America are depleting rapidly. The lateritic ores are becoming increasingly important. Industry growth is closely related to the alloying industry and food processing industries.
Projected Consumption & Prices	-	Growth rate of 5% per annum to 2,500,000,000 lbs. in 1990. Canadian growth will be similar. Prices will probably continue to increase to about $1.30/lb. by 1990.
World Reserves	-	Sulphide ore reserves are about 15,000,000,000 lbs. sufficient for about 20 years. Lateritic ore reserves exceed those of the sulphide ores but are lower in grade and are costlier to process. Lateritic nickel occurs in the Philipines, Indonesia, New Caledonia, Cuba, Venezuela, Greece, and Guinea.

Nickel (Cont'd)

New Mine Production Requirement	-	Approximately 200,000 tons of new concentrate (15% nickel) production capacity must be developed each year to meet growth requirements for world demand.

Mineral	-	<u>Silver</u> (Salient statistics are in Exhibit 8-9)
Uses	-	For coinage, ornaments, art, industrial application and alloys.
World Production	-	249,500,000 oz. in 1963 primarily in Mexico, Peru, U. S. A. Canada and Australia.
Canadian Production	-	46,645,000 oz. in 1966, largely as a by-product from base metals operations.
Major Consumers	-	All government, and the prime industrial nations.
Processing Centres	-	Ores are concentrated at the mine site. Smelting is usually done at lead smelters. Refining is generally completed in government controlled mints.
Prices Feb. 1968	-	$2.09 per oz.
		Increasing industrial uses.
Outlook	-	The high metal price is forcing the withdrawal of silver from coinage.
Projected Consumption & Prices	-	Growth at 1.5% per annum to about 360,000,000 oz. by 1990. Canada's share will increase at 2.5% due to the more aggressive growth of the base metals industries and production may be 76,000,000 oz. Prices will probably level off at present amount.
World Reserves	-	About 3,000,000,000 oz. widely scattered - and sufficient for 15 years. Canadian reserves of 700,000,000 oz. are generally claimed.

Mineral	-	Zinc (Salient statistics are in Exhibit 8-10)
Uses	-	In alloys for die casting, galvanized sheet and strips, in a wide range of products.
World Production	-	9,500,000,000 lbs in 1966. The major producers are the U. S. A., Canada, U. S. S. R., Australia, Mexico, Japan, and Peru.
Canadian Production	-	1,889,000,000 lbs. in 1966 from several mining centres.
Major Consumers	-	Smelters in the U. S. A., U. S. S. R., Japan Canada, Belgium, Australia, France, West Germany and U. K.
Processing Centres	-	Ores are concentrated at the mine sites. Smelters and refineries are located within the major mining centres and in the consuming districts.
Prices Feb. 1968	-	Prime Western at 13.5¢ per lb. delivered f. o. b.
Outlook	-	Has growing importance as surface protection for iron and steel. Increasing popularity in the emerging countries.
Projected Consumption & Prices	-	Growth at 2.5% to about 17,600,000,000 lbs. in 1990. Canadian production growth similar and reaching 3,100,000,000 lbs. in 1990. Prices will follow.
World Reserves	-	About 85,000,000 short tons in Canada, U. S. A., Europe and Australia - sufficient for about 15 years. Canadian reserves are adequate for about 20 years. The Yukon will be an important production centre.

New Mine Production Requirement	-	Approximately 32,000 tons of new zinc concentrate (54% zinc) capacity must be developed each year to meet growth requirements for world demand.

Mineral	-	Petroleum (Salient statistics are in Exhibit 8-11) (including Natural Gas Liquids)
Uses	-	Refined to a variety of fuels and lubricants and feedstocks for petro chemicals; fuels for domestic, industrial heating and for transportation comprise over 90% of total use.
World Production	-	13 Billion barrels estimated for 1966. The main producing areas are the Middle East, United States, Soviet Union and Venezuela. Canada ranks 9th among producing nations.
Canadian Production	-	0.405 Billion barrels estimated for 1967; about 40 percent exported to the U. S.; Canada is about 85% self sufficient in production although about 36% of domestic demand (demand east of the Ottawa Valley) is served by imports.
Major Consumers	-	All industrialized nations. Canadian exports go to U. S. midwest and north west by pipeline.
Refining Centres	-	Usually near centres of population and industry; crude oil usually moves in bulk quantities from producing areas to markets.
Prices	-	Canadian wellhead prices range from $1.80 to $3.25 per barrel depending on crude characteristics and field location. High gravity Alberta crude is delivered to Ontario for approximately $3.10 per barrel including transportation charges. Middle East crude oil prices set international competitive prices.

Petroleum (Cont'd)

Outlook	-	Petroleum industry historically characterized by oversupply, and shut in productive capacity. Other energy sources particularly nuclear power and natural gas will prove strong competition in selected market segments. Yukon oil would be at a severe transportation cost disadvantage in the existing Canadian markets; but could be marketed competitively via pipeline to Skagway in Pacific international markets. Liard Basin and Mackenzie delta 1970 wellhead prices would likely be $1.60 to $1.90 per barrel.
Projected Consumption & Prices	-	Demand will likely continue to grow at healthy rate of about 6 percent per year as more nations become industrialized. World requirements could be 50 billion barrels annually by 1990 with prices rising only slightly above current levels. Jumbo tanker movements will continue to reduce bulk transport costs.
World Reserves	-	Estimated at over 385 billion barrels in 1966 - a 32 year life index; occurrence is widespread throughout the world; 62% of reserves are in the middle east; 2% in Canada not including 300 billion barrel potential of Athabaska tar sands. Canadian exploration activity is shifting north and to coastal areas.

Mineral	-	Natural Gas (Salient statistics are in Exhibit 8-12)
Uses	-	Mainly used as a domestic heating fuel and industrial energy source; also as raw material for plastics and fertilizers.
World Production	-	Estimated at some 22,000 billion cubic feet (BCF) in 1966. Main producer is the U. S.; Middle East produces large volumes in conjunction with Petroleum - but little is used as fuel and is not in the above estimate.
Canadian Production	-	1,400 BCF in 1966 - continuing the 6 percent growth rate trend started in 1962; prior to the average annual growth rate was 23.5% per year. Most production in Alberta and North east B. C. Canada exports about 40% of production to U. S. mainly to the northwest.
Major Consumers	-	Households, energy intensive industries, thermal power generation - a favoured fuel if economical. North America consumes by far the largest amount in the world.
Processing Centres	-	Located near production areas. Considerable amounts of natural gas liquids and sulphur are recovered from natural gas in preparing it for pipeline transportation to markets.
Prices	-	Canadian wellhead prices generally 10¢ to 20¢ per 1000 cubic feet (MCF). Consumer prices vary considerably with distance from source and type of service contract and have generally risen rapidly in Canada during the 1950's. Average price ranges from about 35 cents per MCF to $1.00 per MCF for industrial and domestic sales respectively.

Natural Gas (Cont'd)

Outlook	-	Continued healthy demand growth but strong competition from oil electricity for home heating. Any substantial reserves discovered in the Yukon should have little difficulty in finding markets on this continent; and could possibly compete in the orient with Middle East gas. Currently unutilized Middle East reserves could become more important with the advent of liquid methane movement by ship, which is now technically and in some cases commercially feasible.
Projected Consumption & Prices	-	3, 000 BCF in Canada by 1990 with as much again exported to U. S. Average annual rate of growth 6. 1%. Moderately increased prices projected.
World Reserves	-	Proven Canadian marketable reserves in 1966 estimated at 49, 269 BCF or 38. 6 years life index, 43. 8 years probable. Reserves of at least 3, 000 BCF would likely be required to justify marketing Yukon natural gas beyond the Yukon borders.

EXHIBIT 8-1

ASBESTOS 1950-1990

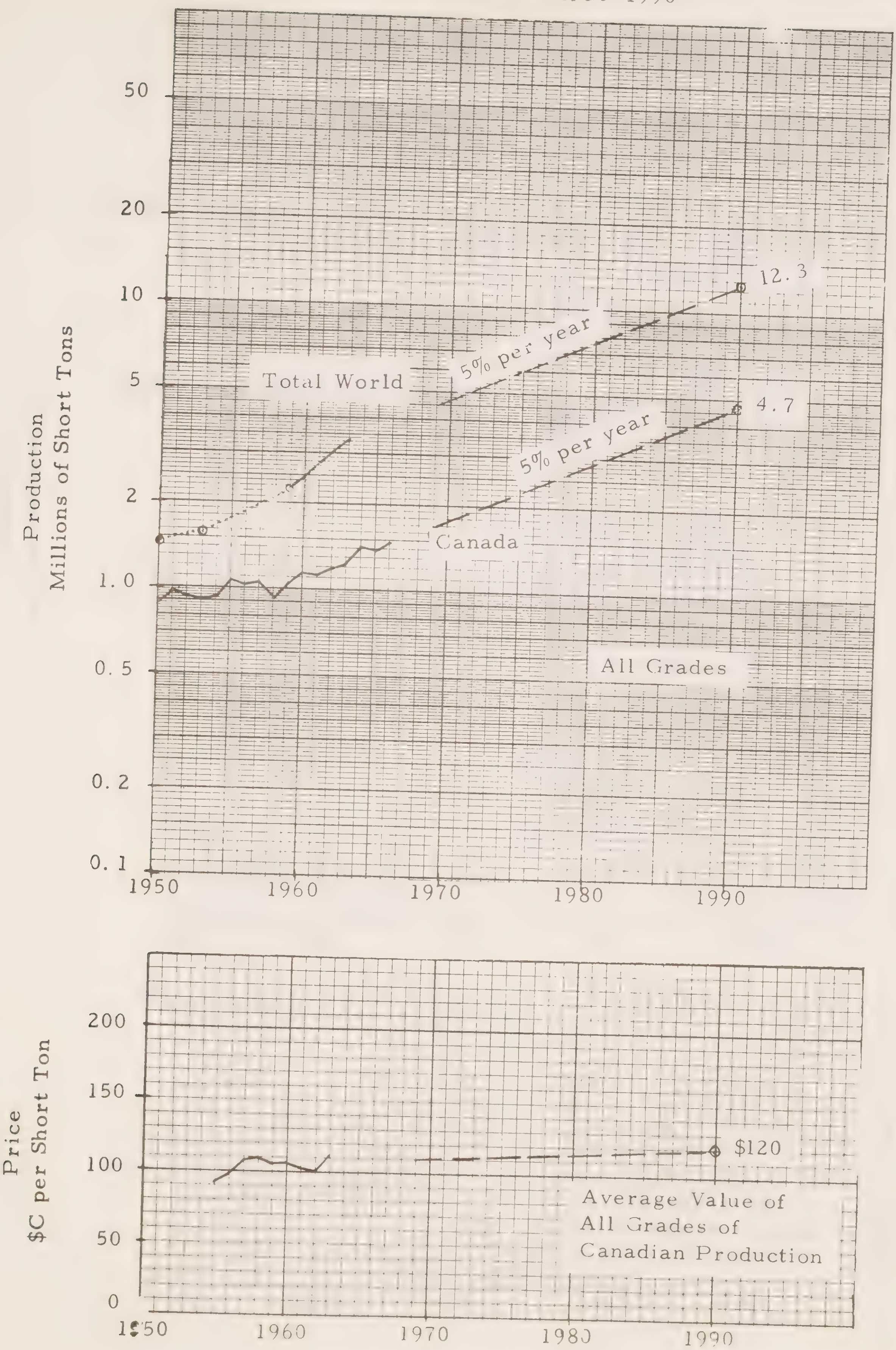


EXHIBIT 8-2
COAL 1950-1990

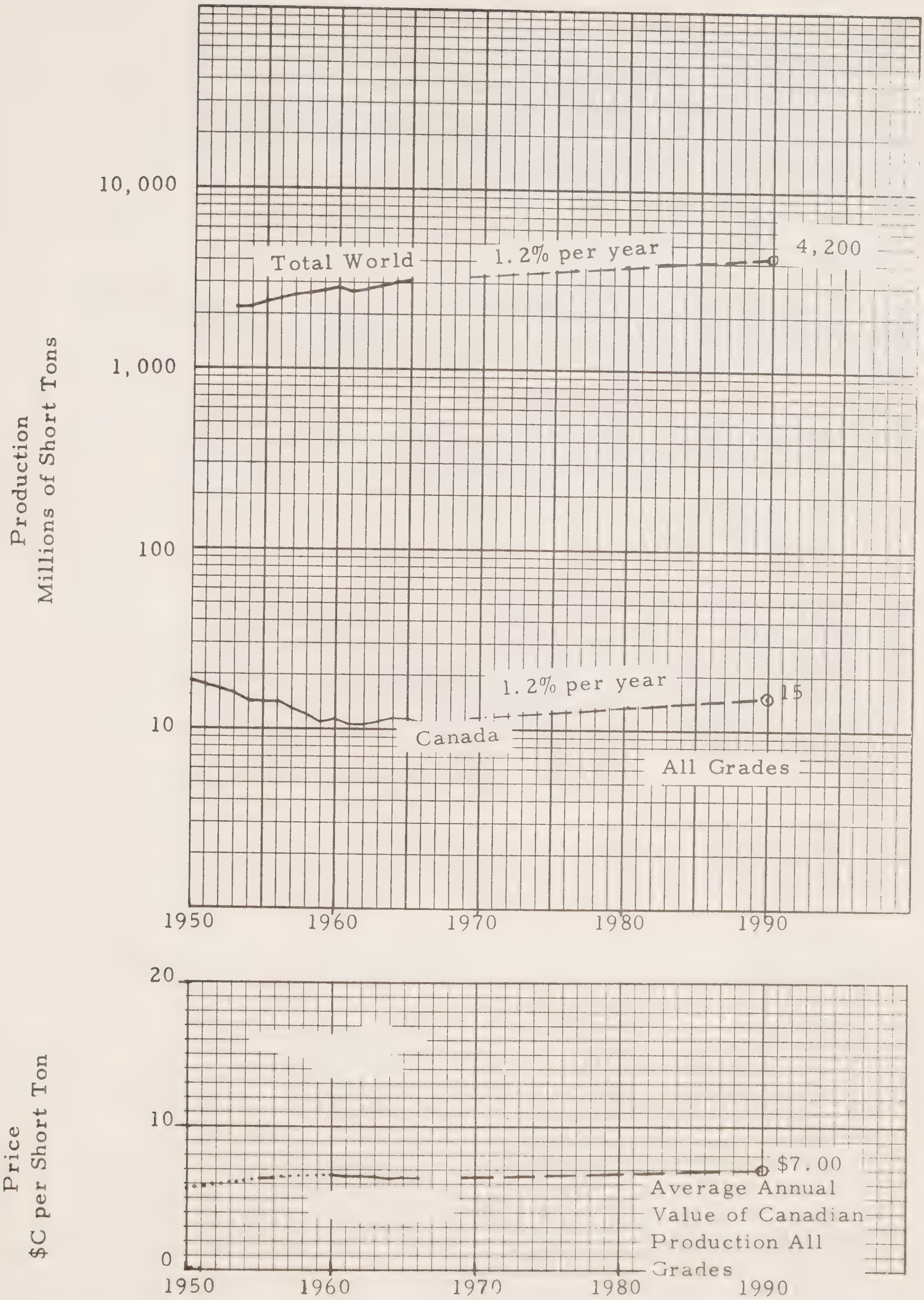
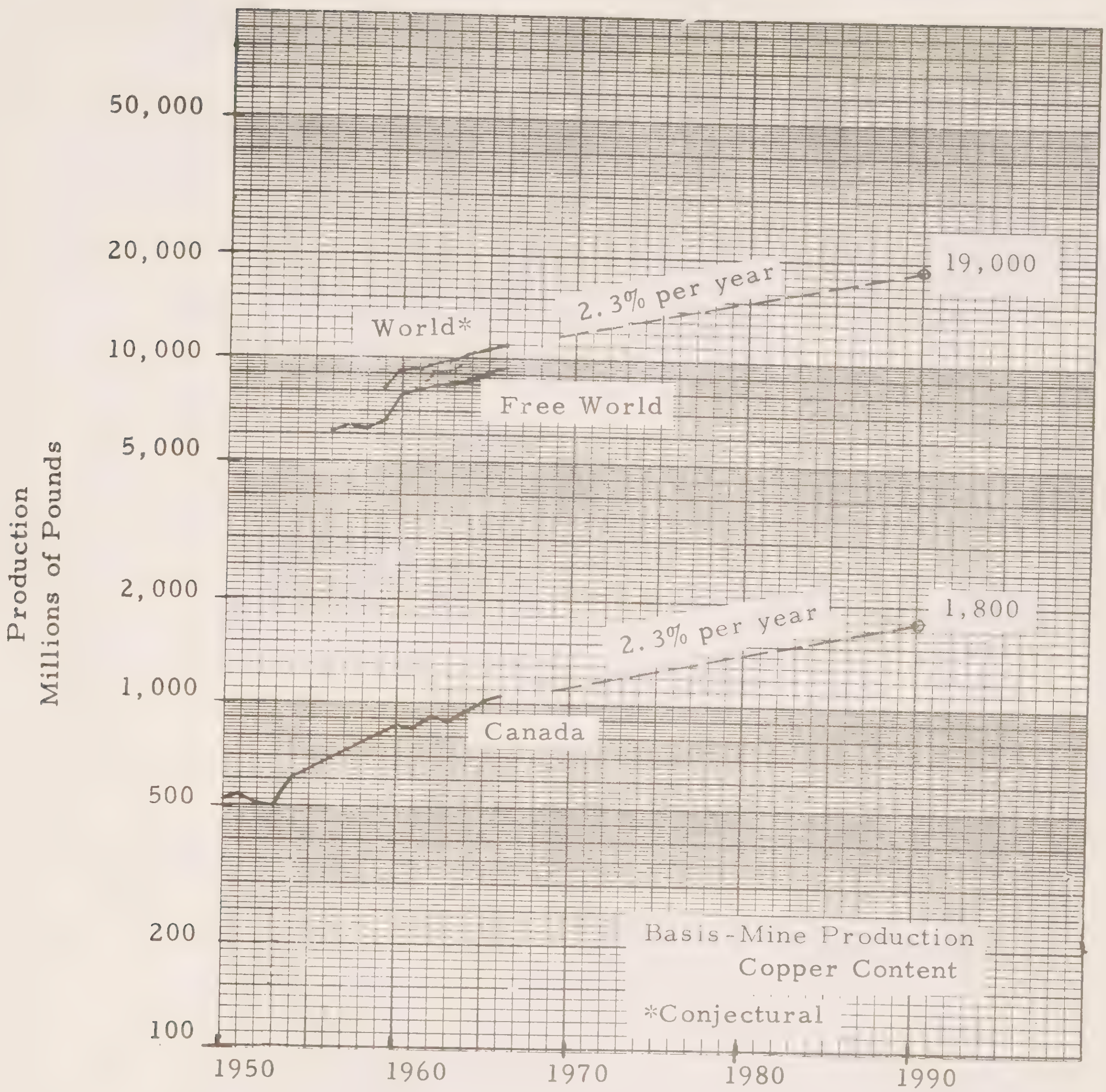


EXHIBIT 8-3

COPPER 1950-1990



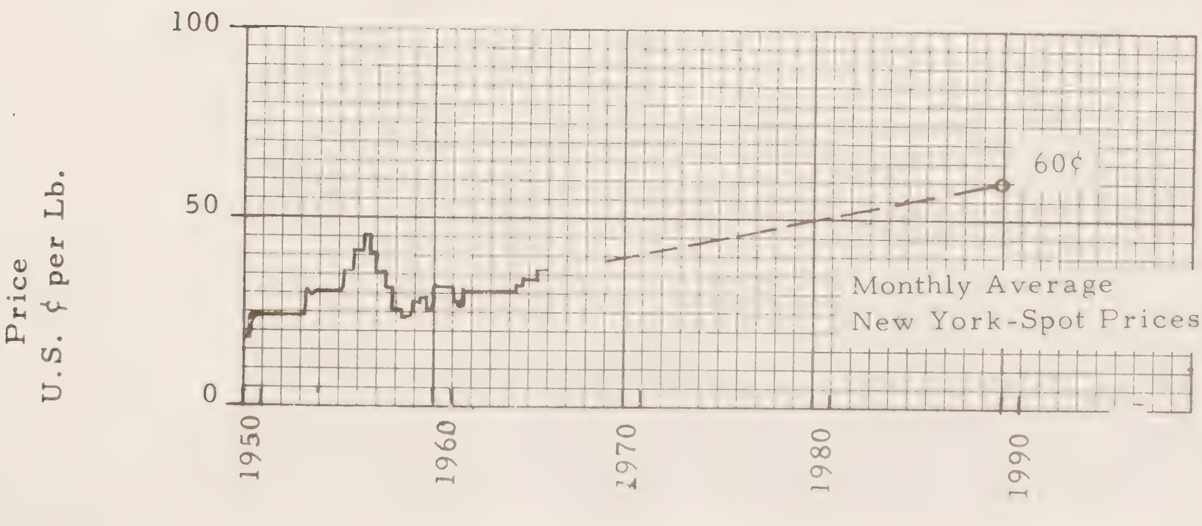
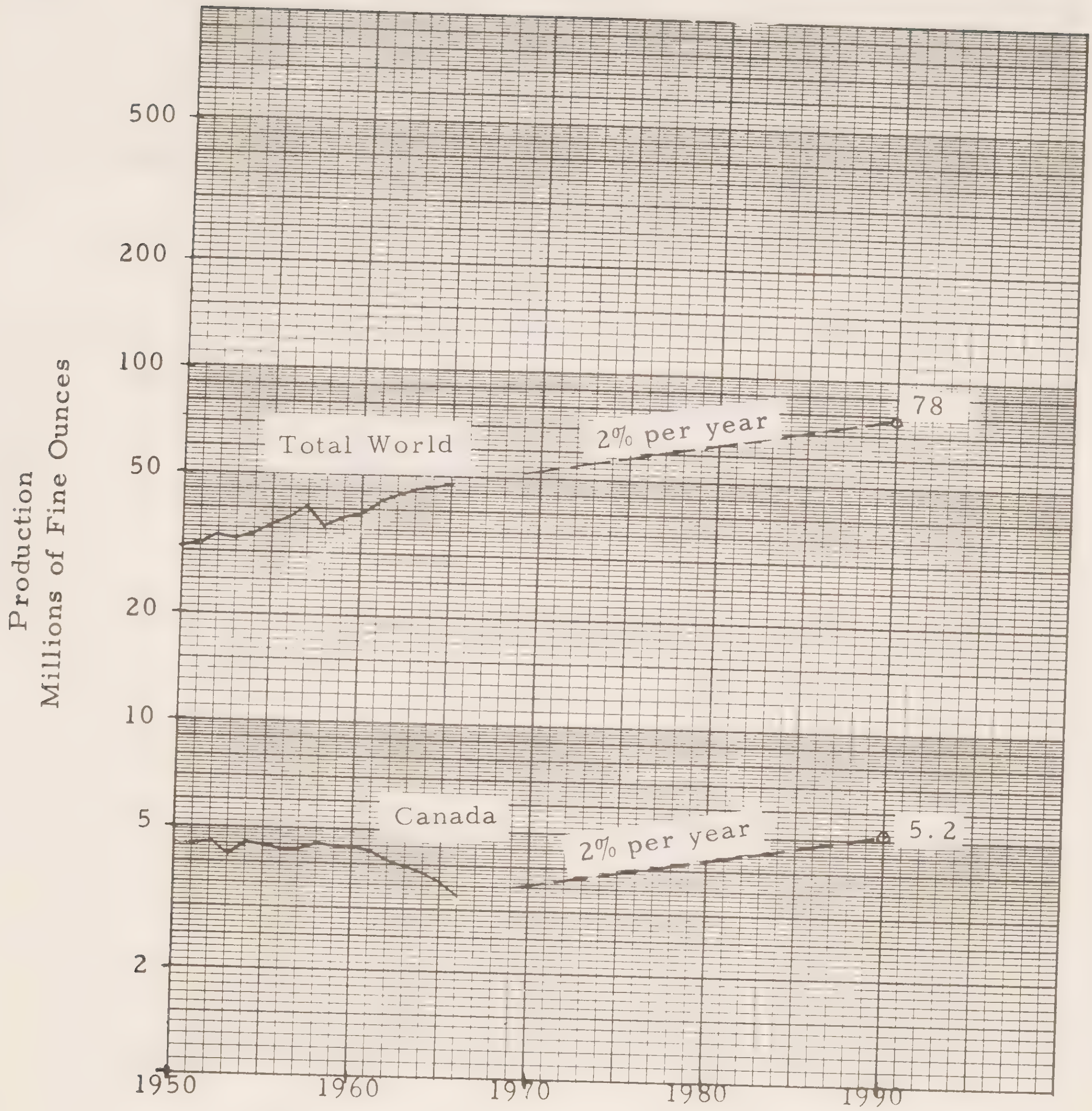


EXHIBIT 8-4

GOLD 1950-1990



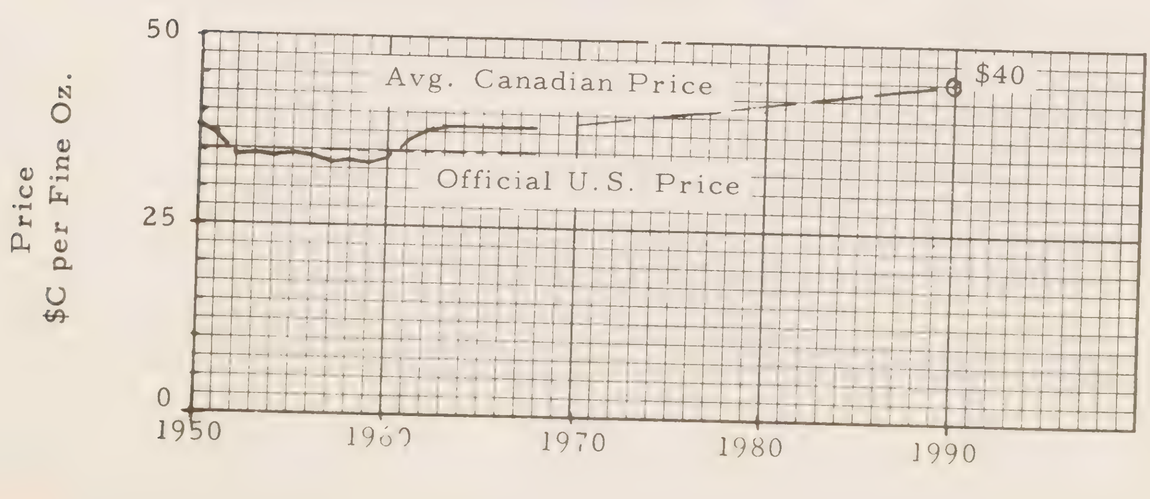


EXHIBIT 8-5
IRON ORE 1950-1990

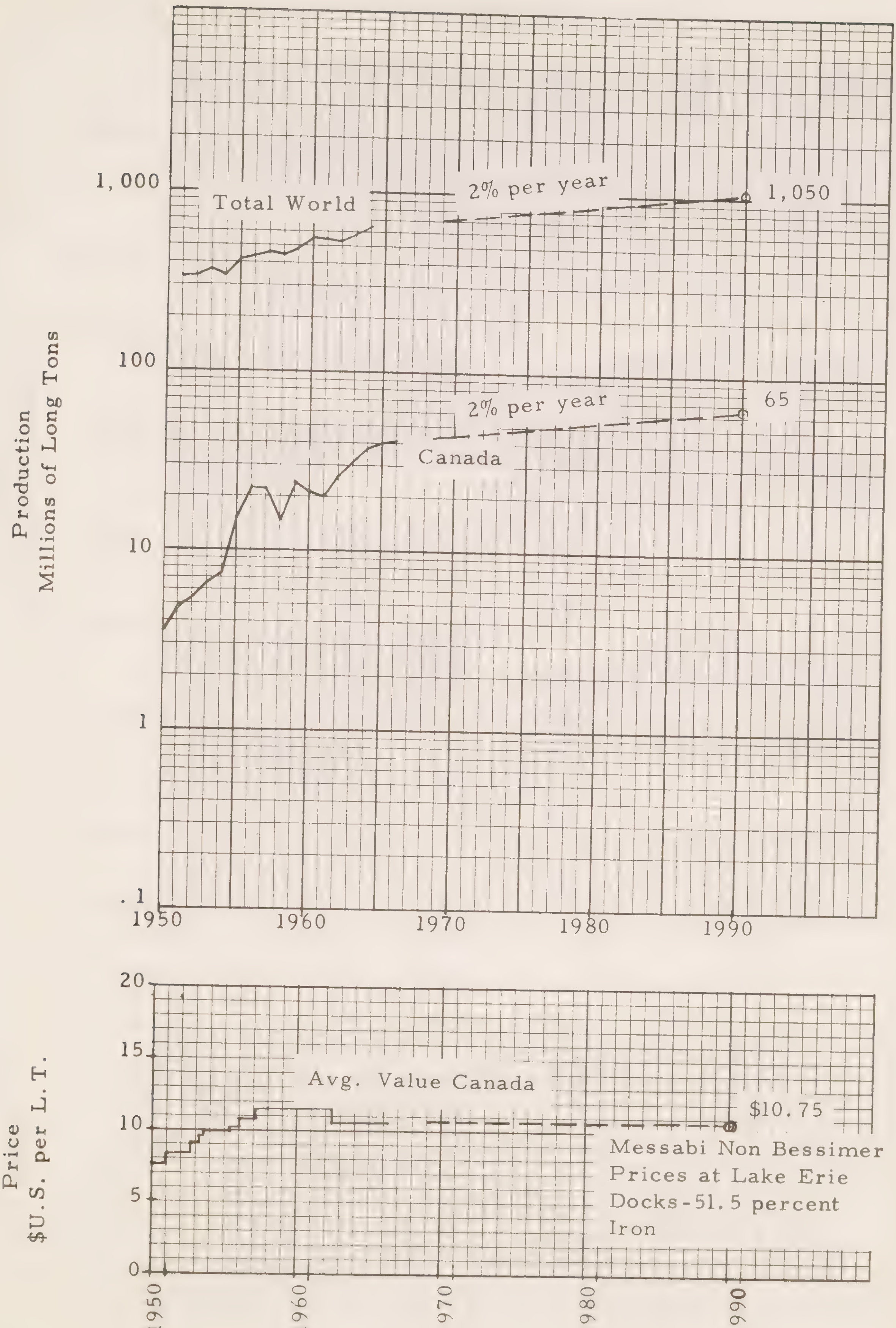


EXHIBIT 8-6

LEAD 1950-1990

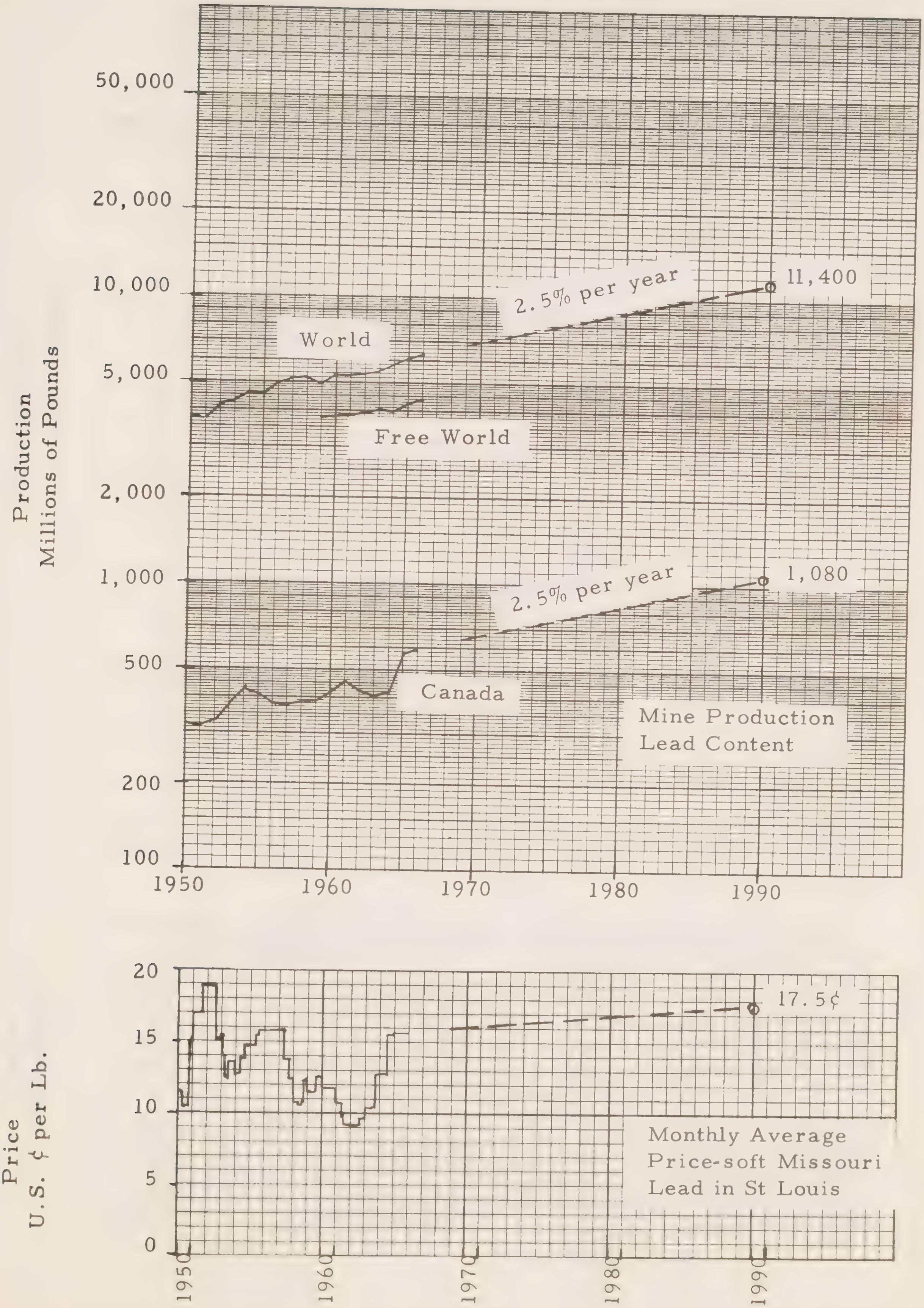


EXHIBIT 8-7
MOLYBDENUM 1950-1990

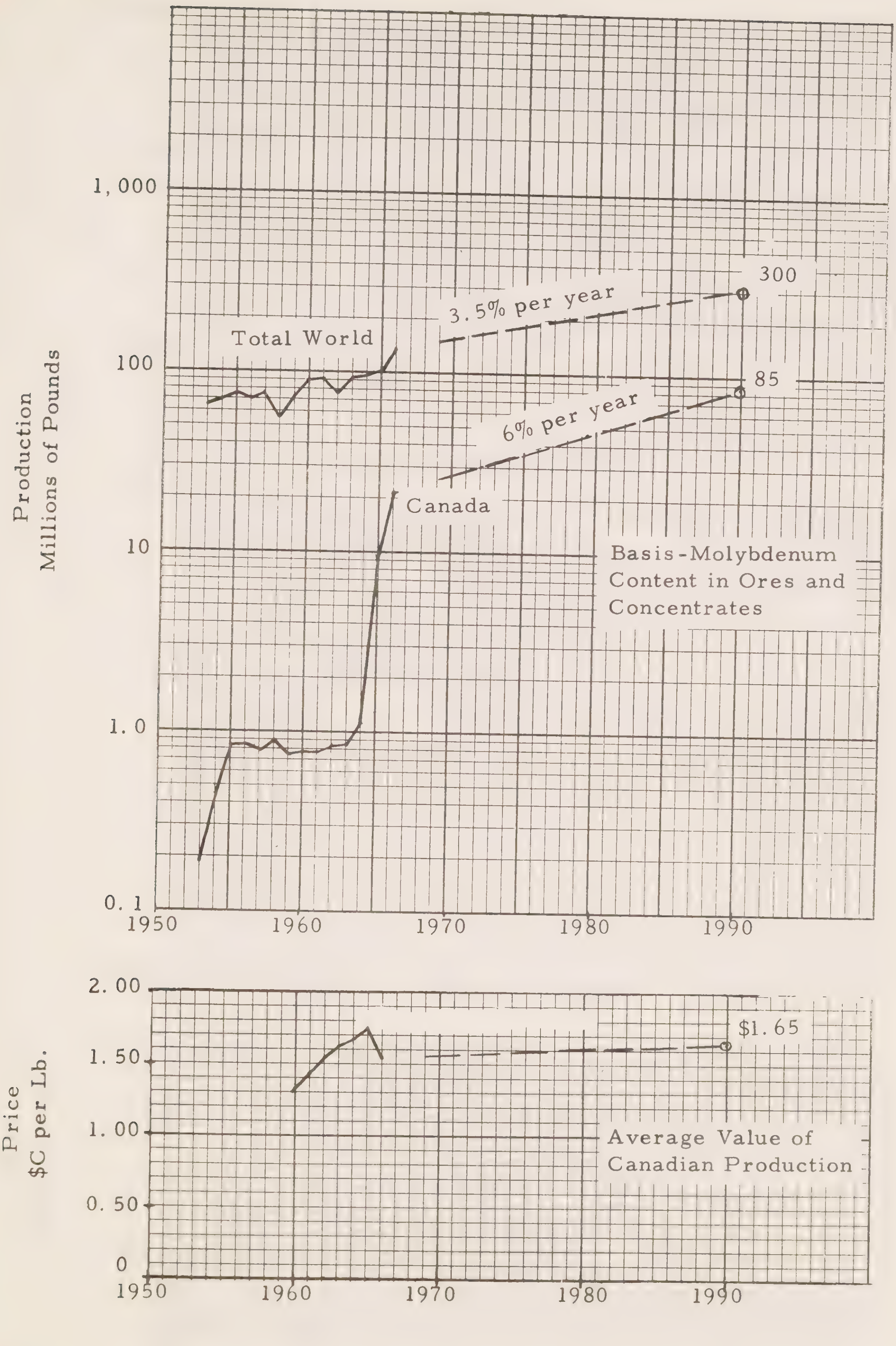


EXHIBIT 8-8
NICKEL 1950-1990

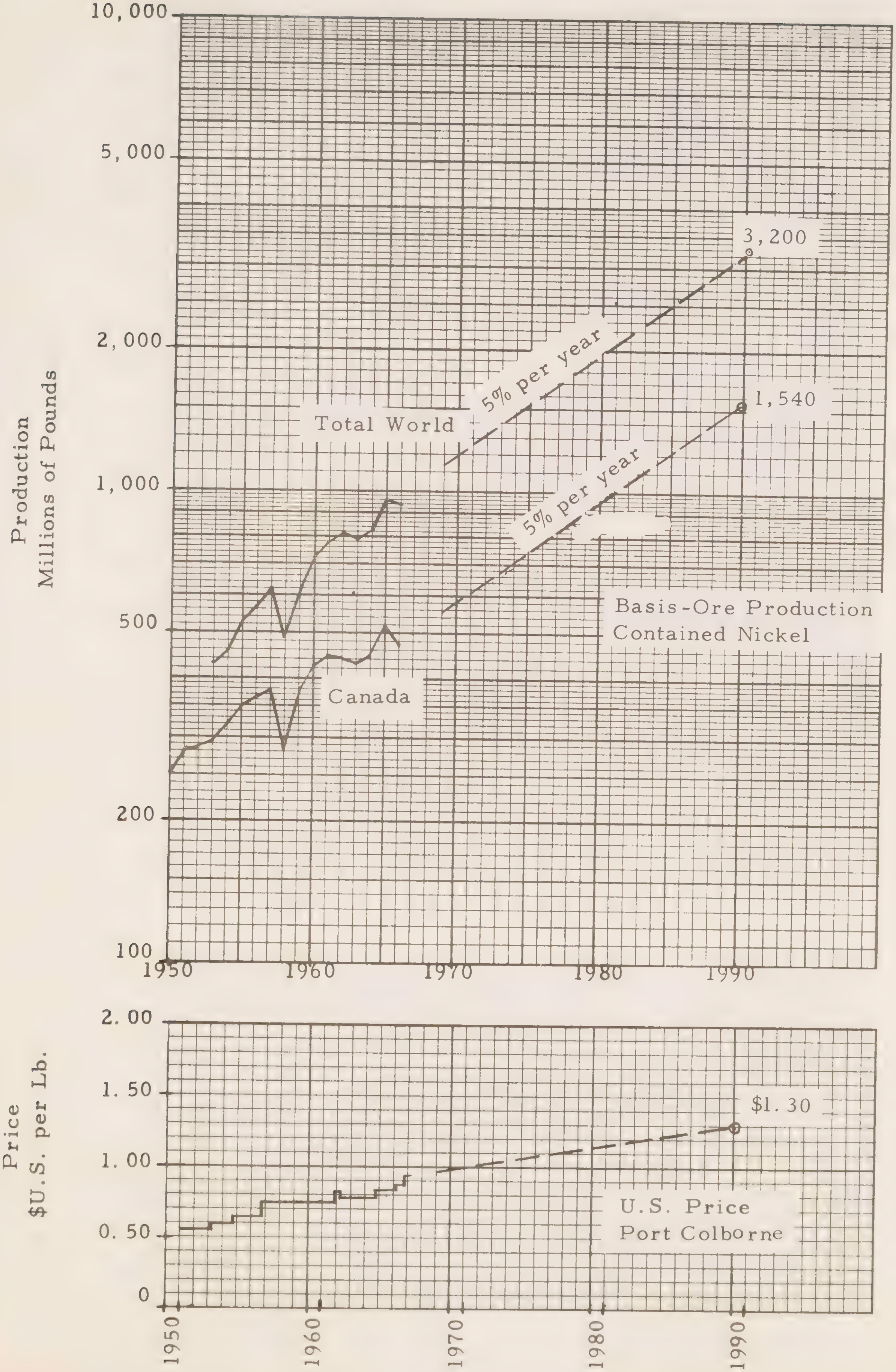
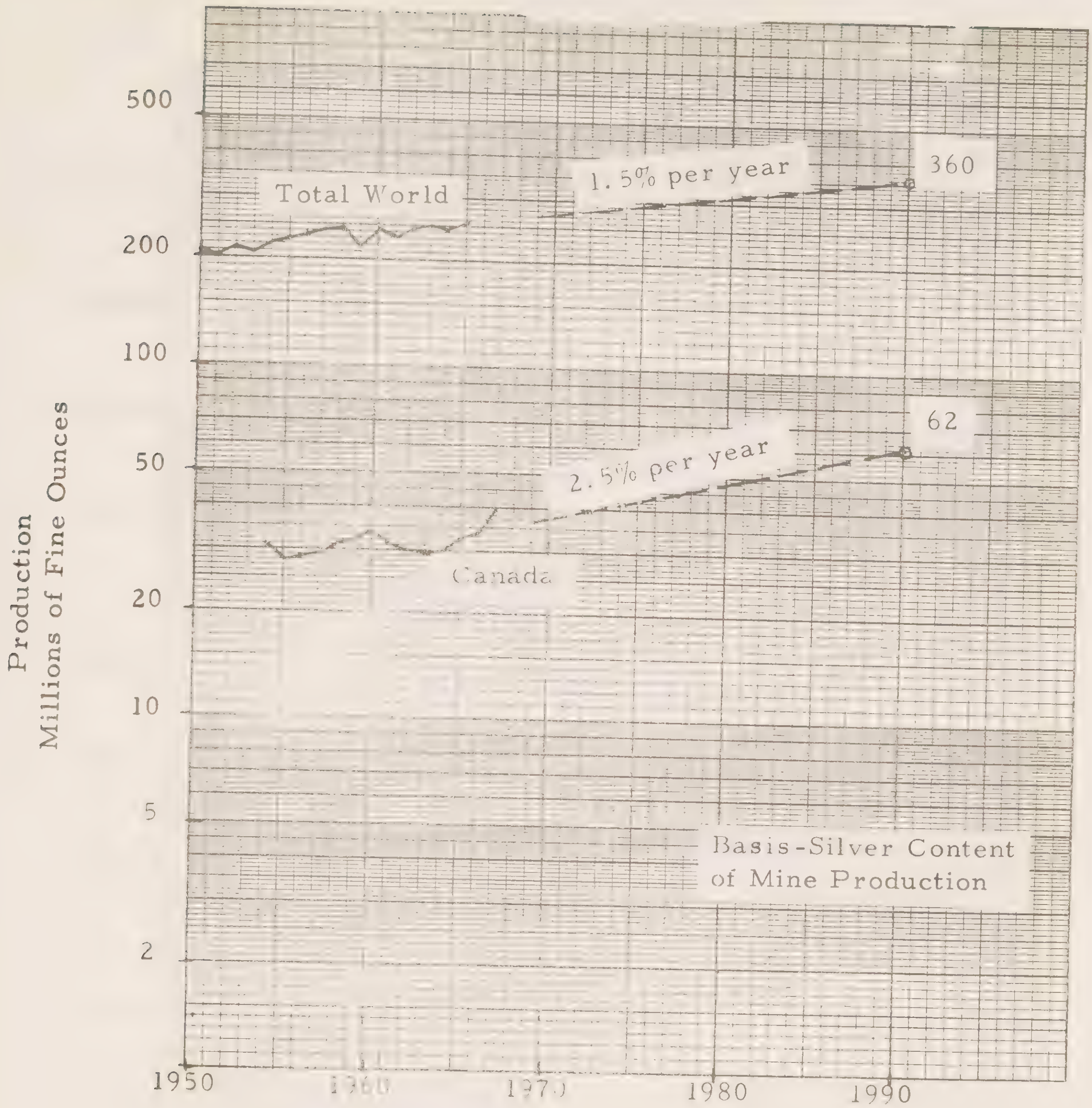


EXHIBIT 3-9
SILVER 1950-1990



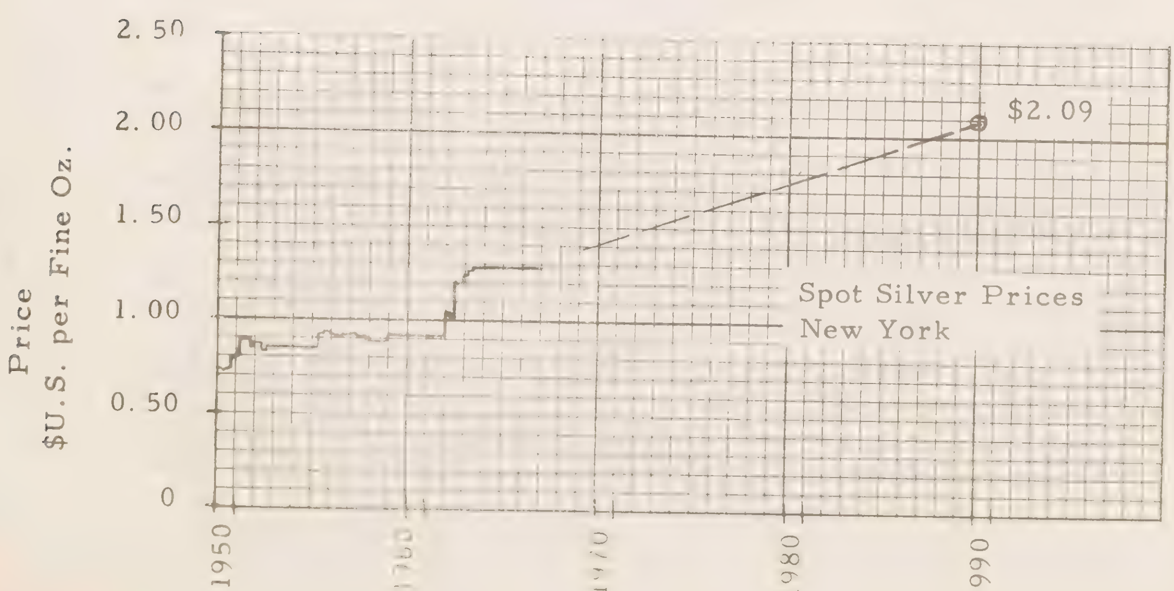
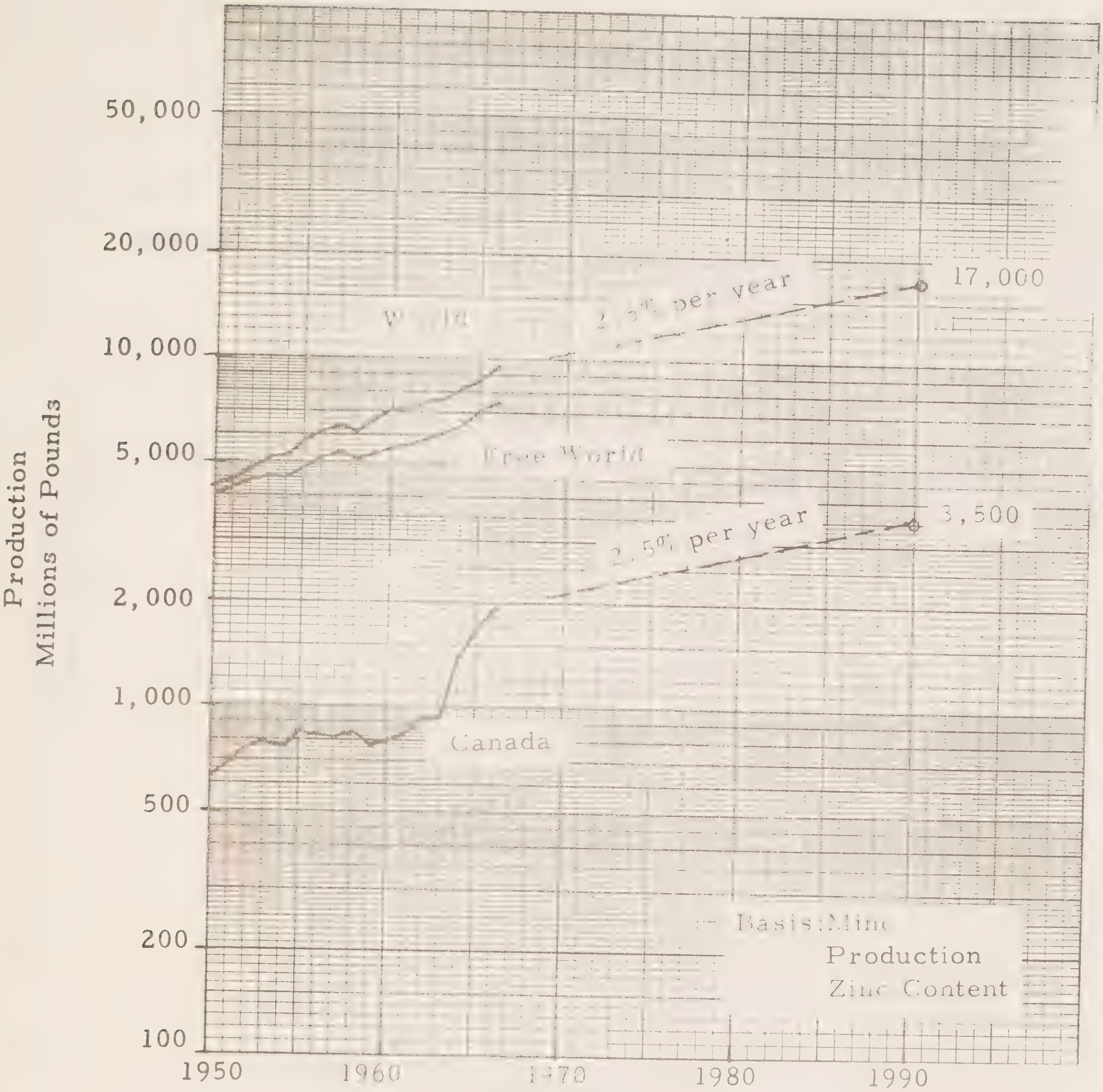


EXHIBIT [illegible]-10

ZINC 1950-1990



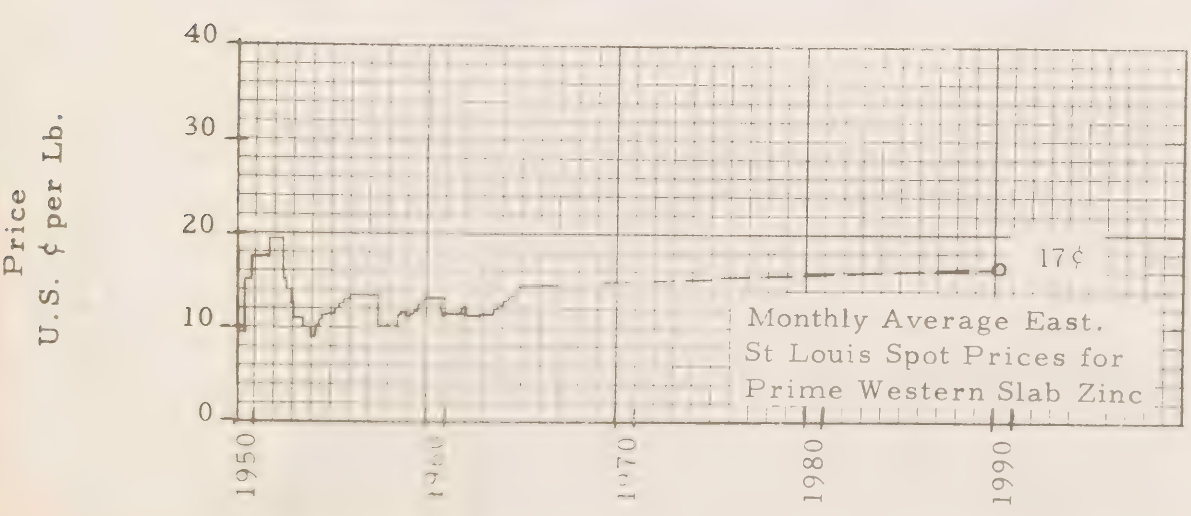
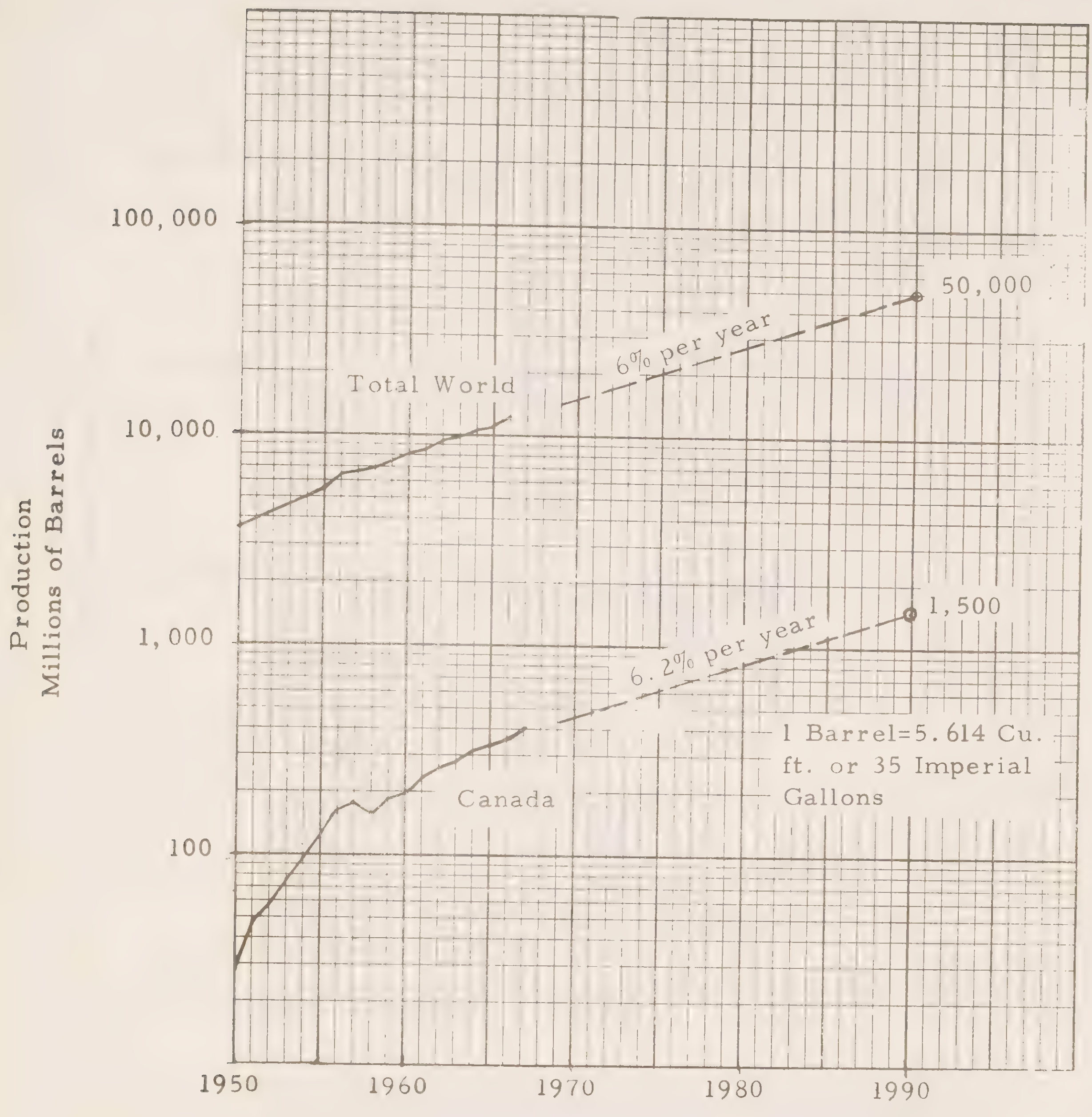


EXHIBIT 8-11

PETROLEUM AND NATURAL GAS LIQUIDS

1950-1990



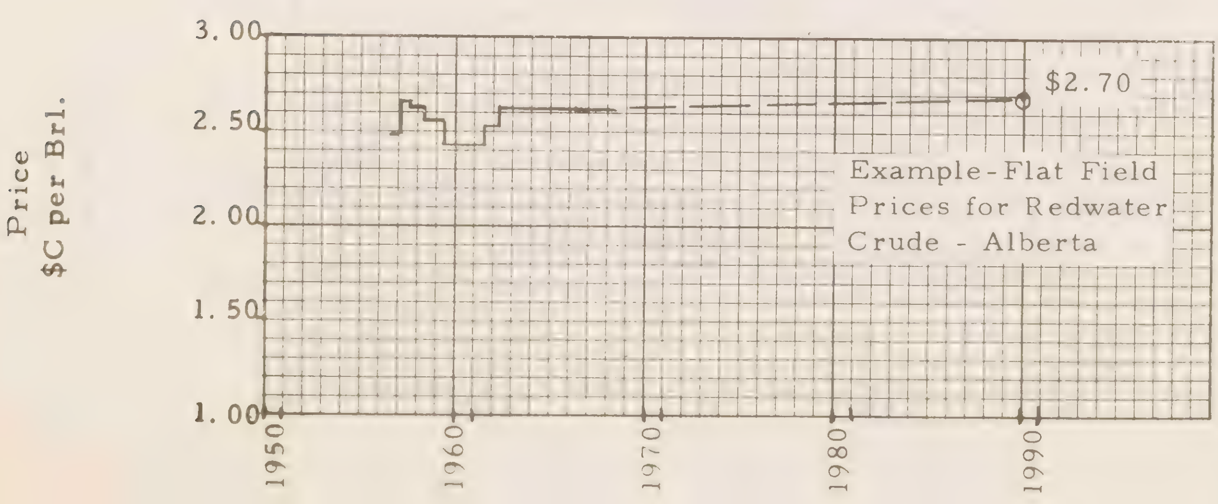
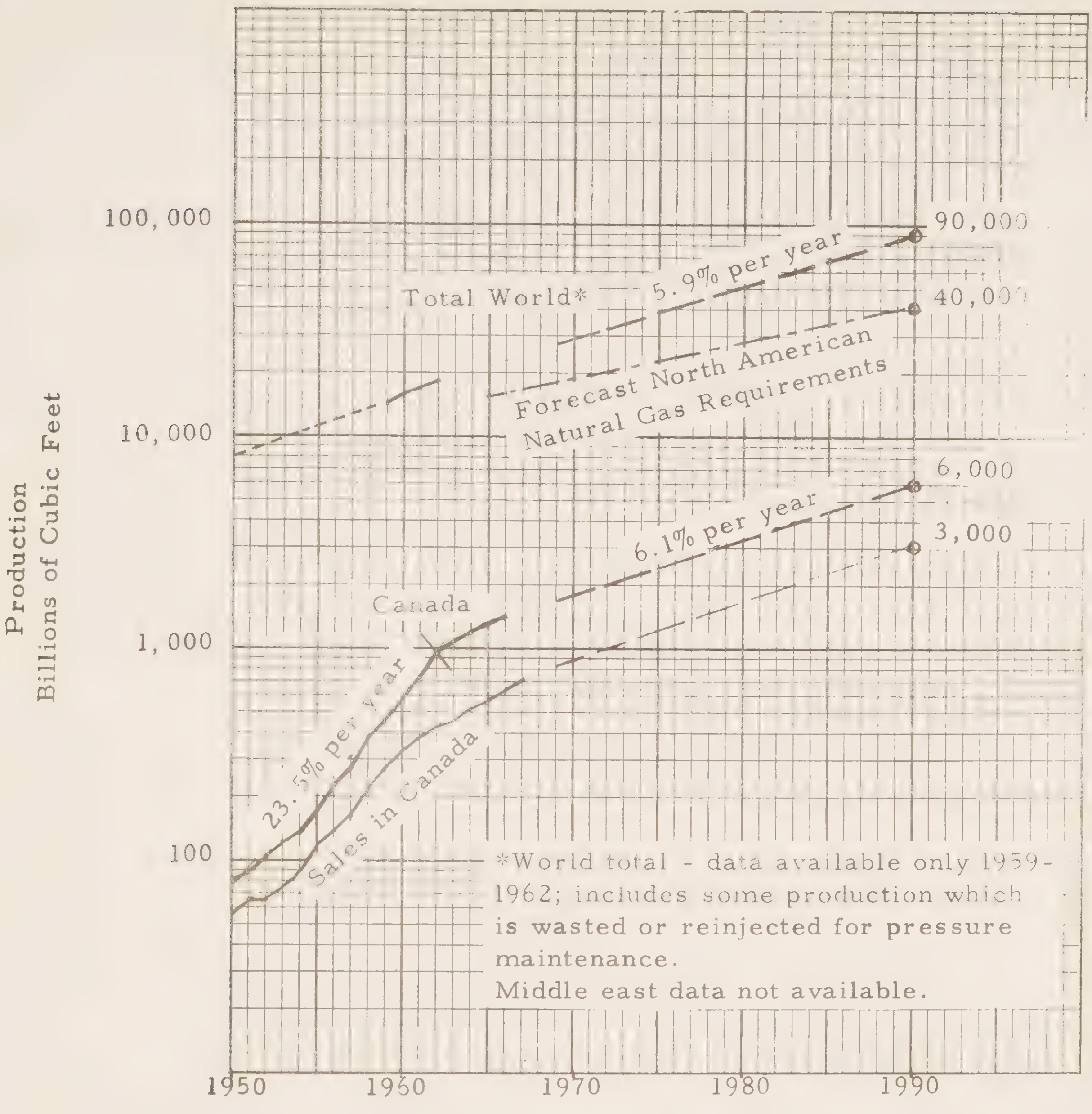
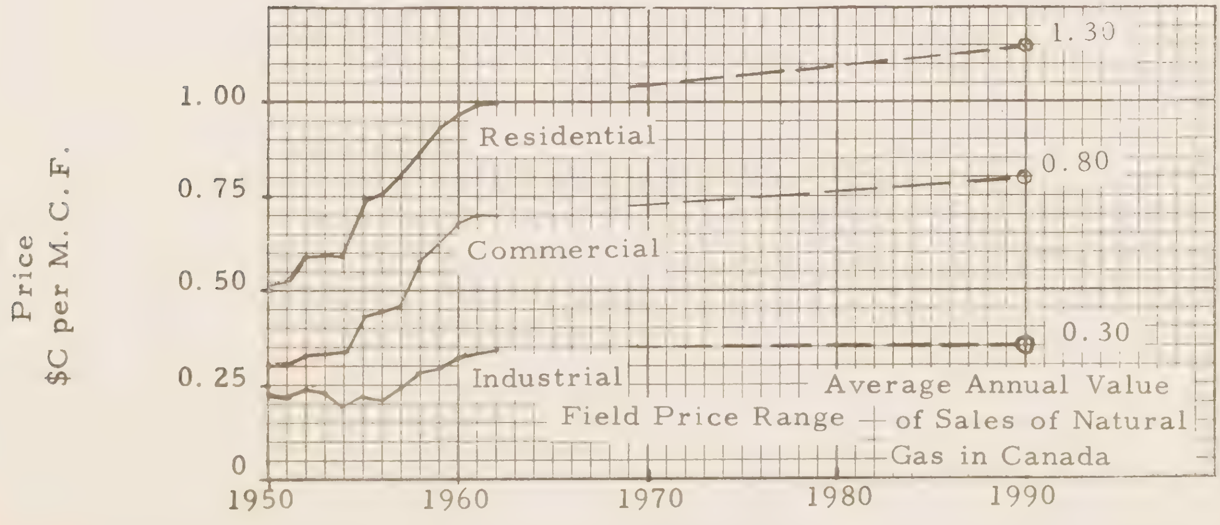


EXHIBIT 8-12
NATURAL GAS 1950-1990





CHAPTER 9

ANALYSIS OF THE YUKON MINERAL INDUSTRY

Resources

The Yukon is characterized by a broad diversity of mineral occurrences scattered throughout the territory. To date, the main showings have been found where access has been relatively easy. The deposits currently being developed are those predominantly rich in lead, zinc, silver, asbestos, and copper minerals. Local conditions which give rise to relatively high production costs allow only the high grade deposits to be considered for mining purposes. Among the large scale operating mines the cut-off grade is dependent upon trucking distance from Whitehorse and is estimated at $14.00 per ton of ore provided the concentration ratio exceeds 6 to 1. The cut-off grade in small operations can vary between $30 to $60 per ton of ore. Because of these restrictions there are a number of deposits that have ample tonnage for possible future mining operations; however, they are now dormant and await improved conditions before production plans can be considered.

The mineral deposits that are in less active stages of development than the asbestos and lead-zinc ones are those containing nickel, coal, iron ore, and molybdenum. These, with the exception of the Crest iron ore deposit, have not been explored to a large extent and very little information is available about their processing characteristics, geological structure, and origin. Considerable field work will be necessary, and must be encouraged, to develop these into commercial prospects.

The copper-nickel area near Quill Creek is scheduled for an increase in exploration activity this year. Nickel showings have also been detected in the Selwyn Mtns. but access into this region is presently difficult. There is also a strong likelihood of finding porphyry type molybdenum-copper ores in the Wolf Lake and Kluane Lake areas.

Coal of a sub-bitumous and bitumous grade is widespread and occurs in approximately 10 large areas in the Yukon. The best known of these deposits is at Carmacks which has been mined on a small scale for nearly 40 years. The other areas have not been explored extensively, despite suggestions that coking coals may be expected, and very little research data is available about these coals. The very high cost of hydro-electric power generation in the Yukon suggests that thermal-electric power from coal may be quite competitive and is worthy of serious consideration. In addition, this development would utilize a natural resource that would otherwise be unexploitable. A 300 MW thermal plant would consume one million tons of coal annually and the coal mine would provide direct employment for more than 300 personnel.

Industrial minerals are of litle interest in the Yukon because of the small local market for such minerals. Gypsum, barite and limestone are known to occur throughout the southern half of the Yukon. Their development is unlikely in the near future unless mass industrialization occurs.

Oil and gas have been sought in the south-east near Bear Creek, in the central region on the Eagle Plain and Peel Plateau, and in the far north near the Mackenzie River delta. Thus far, gas and oil have been found but definitive results have not been divulged. The regions are generally considered to have some gas and oil potential but they will require considerable exploration expenditures for further development. More intense activity is unlikely unless major oil or gas fields are discovered in regions adjacent to the Yukon which would justify pipeline extensions from Alberta.

The Government measures that are most likely to stimulate new exploration in the Yukon are those which will tend to lower the costs of exploration - such as the construction of development roads and airfields in presently inaccessible areas. The formation of a long term mineral development policy and the need for a comprehensive mineral resources inventory would also be highly desirable.

Mine Development

Mining in the Yukon commenced at the turn of the century and was founded on a very high-grade alluvial gold

occurrences in the Klondike. These gold findings have since been largely depleted; however, the philosophy of working high-grade ore deposits have continued to the present day. The reasons that high grade ores are emphasized are the difficulty of access, the very high costs of exploration, development and production, the long distances to the established markets and high transportation charges.

Until recently the operators' outlook was a short-term one and there have been few producers with announced long-term mining intentions in the Yukon. The United Keno Hill and Yukon Consolidated Gold operations persisted for over 25 years, but always on a short-term basis. The new Cassiar and Anvil operations, on the other hand, are planned to produce for over 20 years due to enormous ore reserves and favourable market conditions. They have also been responsible for the construction of modern mining camps in what was formerly wilderness country.

Additional large orebodies like Clinton and Faro are likely to be found and they will be brought into production if they are rich enough. The presently marginal deposits, and subsequent discoveries of similar ores will remain dormant until the conditions that contribute to high costs are relieved. The most important relief measures that can be considered presently are those that will lower the presently high costs of electric power, freight and housing.

Physical Conditions

The main physical conditions that influence the mining industry in the Yukon relate to climate, physiography and location. The climate imposes extra capital requirements for insulation and heating, as well as special considerations for the equipment that must operate under severe weather conditions. This latter problem increases in intensity as one moves northwards from the 60th parallel. The permafrost zone creates additional engineering considerations that also increase capital costs. The regional climatic conditions influence townsite development and special safety measures must be provided to ensure reliable public utilities services. The climate affects the people who have to work in the region, especially during the long wintery days, when the desire to go south for a holiday is very strong. These conditions suggest

that the population and mining companies in the Yukon are subjected to additional capital costs which are estimated at 20% more than in southern British Columbia. Higher living and operating costs are also experienced by the populace because of special maintenance and extra heating requirements in the Yukon. The net result is that considerably more materials and supplies are required for operations and existence than elsewhere, and the 11% Federal Sales Tax on building materials and supplies tends to compound an already high cost problem.

The St. Elias and Coast Mtns., trending in a northwesterly direction, are a barrier to the desired southwesterly flow of traffic from the Yukon towards the Pacific Ocean. This problem is technically serious because of the nature of these mountains which among the highest mountains in North America, they are infested with glaciers, and plunge steeply into the Pacific Ocean leaving very sheltered areas available for potential port development. Physiographical restrictions suggest that practical transporation routes from the Yukon must arc south-easterly into British Columbia before suitable access routes can be found to reach possible tidewater ports. As a result, haulage distances from ore deposits in the Yukon will probably be longer than they would be otherwise without interference from the formidable mountain systems. Inherently higher freight costs can therefore be expected by Yukon operators unless some equitable means of relief can be devised to improve the Yukon's competitive position with respect to other mining centres.

The Yukon is isolated from the rest of Canada and it is a long distance from most traditional Canadian consuming centres. Vancouver is at least a day's distance by air from Whitehorse; Toronto is about two days away. The pursuit of business in the Yukon requires that delays be provided for communications and travelling; these aspects add to the cost of doing business in the Yukon. The trend to high speed aircraft will relieve this problem, but measures must be devised to reduce the cost of communications with the outside world.

The closest custom smelters are more than 1000 miles from the mining districts of the Yukon. Because of its isolation in the north-west corner of North America, the

Yukon Territory is somewhat deprived of Canadian markets and its best potential lies in the Pacific regions, primarily in Japan and the western U. S. centres which are more than 2500 miles distant. The smelter locations in the Pacific region are shown in Exhibit 9-1, and it is readily apparent that Yukon mining companies must bear extra freight costs to reach these distant points. This situation can be relieved only by attracting a smelting company to the Yukon - this may be a difficult task but not an impossible one to accomplish as a long term objective.

The Transportation Problems

Several alternative schemes have been proposed by various bodies for extending railroads and highway systems into the Yukon to serve the mining industry. The rail routes suggested to date are the following:

1. Extension of the Pacific and Great Eastern Railway from Prince George, B. C., northwards to Cassiar and Watson Lake, and possibly to Ross River, Mayo and Crest. This route, approximately 1000 miles long, would connect with the east-west mainline of the CNR at Prince George.

2. The northwards extension of the CNR from Hazelton, B. C., to Telegraph Creek, Cassiar, Watson Lake, Ross River, Mayo and Crest. This route would also be approximately 1000 miles in length and would connect with the east-west mainline system.

3. A new railway line from Haines to Haines Junction, Carmacks and Ross River. This route would be approximately 400 miles long and would serve the Ross River lead-zinc district.

4. The eastward extension of the Alaska R. R. from Fairbanks to Clinton Creek and Dawson, a distance of about 250 miles, and extensions further eastward to Crest via Mayo and to Ross River via Carmacks.

5. Conversion of the White Pass and Yukon R. R. system from its present narrow-gauge track to standard-gauge and extending it in three directions from Whitehorse - namely to (i) Ross River, (ii) Carmacks, Mayo and Crest, and (iii) Burwash Landing.

These five alternatives pose complex issues of a legal, financial, international, political, and regional development nature. Extensive feasibility studies are needed to rationalize the best means of serving the Northwest Region adequately and the Yukon effectively.

Main highway and road networks in the Yukon are presently contemplated by the Department of Northern Development. The British Columbia Government is presently extending its present road network from Stewart to Telegraph Creek and ultimately to Atlin and Cassiar where they will meet the existing road systems extending southwards from the Yukon. An access road from Dawson has been extended 70 miles northwards towards Fort Macpherson, and ultimately to Inuvik and the Coppermine area in the Northwest Territories. The extension of a road westwards from Yellowknife to the Canada Tungsten Mine is also under consideration.

The present committments for road building in the Yukon and the Northwest Territories are however, approximately $10 million per year - of this amount perhaps one third is destined for work in the Yukon. With road building costs presently at about $50,000 per mile for gravel surfaced highways, the present budget provides only 70 miles of new roads per year in the Yukon and 130 miles in the Northwest Territories. At this budget rate the ambitious road-building programs for the North will take many decades to complete.

The Yukon Territory needs an extensive network of development roads to facilitate exploration in presently inaccessible areas - at least 2000 miles of such roads would be desirable in the Yukon during the next ten years. A case may therefore be advanced for the construction of low cost development roads built initially to lesser standards than those for the current highway construction program. The construction of such roads at $20,000 per mile would require a separate $4,000,000 annual budget to achieve this goal.

A regional approach to mining development throughout Alaska, Yukon, Northwest Territories, and Northern B. C. is necessary to rationalize complex transportation systems and port facilities that are needed to stimulate mining developments throughout this entire territory.

External Market Forces

The indicated world ore reserves for asbestos, lead, and zinc are presently expected to be depleted within 20 years. Under these circumstances keen exploration interest can be expected in areas known to contain such minerals. The Yukon happens to be such an area, but the products from the mines must be deliverable to tidewater ports at competitive costs to stimulate international attention towards further large scale mine development in the Yukon.

The establishment of a mine is usually costly, and is done to fulfill long term marketing contracts and production objectives. The expected ore grade and metal prices have some influence on the decision to open a mine but new mining projects are generally not justified unless the recoverable ore grade is sufficiently high to permit profitable operations under depressed metal prices. As a result short-term fluctuations in prices and ore demand will affect the timing and location aspects for new mine developments and exploration efforts; such changes, however, do not seriously influence the established and soundly-based mining operations. The regions and ore deposits that offer the best profit potentials to the mine developers will undoubtedly be the ones to receive favourable attention. An improvement in the Yukon's competitive position would be a great inducement for accelerating mine exploration and development there in view of the highly favourable prospecting areas within its borders. The uncertainties of market fluctuations can be overcome somewhat by inviting and encouraging the establishment of mining companies that are well connected in the production and sale of primary mine products.

The present open pit ore grade at Anvil represents metal values of $34.00 per ton at the present prices. The lowering of lead and zinc prices by 1¢ per lb. to 13¢ per lb.

would lower the contained metal values by about $2.00 per ton; a 50% drop in silver prices back to the $1.00 per oz. level would decrease the ore value by another $1.00 per ton. Both of these reductions would probably be absorbed by Anvil and the company is likely to be profitable even at a 25% reduction in metal prices. The New Imperial mine, however, with a lower ore grade of $14.00 per ton could not stand a similar price drop as easily as Anvil. The importance of improving the present disadvantages of the mining industry is self-evident - only in this manner can the mines be assured of survival under depressed conditions.

Smelting

The only foreseeable opportunities for secondary industry in the Yukon are for the concentration and smelting of local mine products. These are logical considerations because ample reserves for lead-zinc-silver, and iron ore are proven, and because low-cost energy in the form of coal or electric power is potentially available in the large quantities needed by such secondary industries.

The lead and zinc smelting capacities in Canada and in the world are continually increasing to meet the growing demand for these metals; consequently, a new smelter complex is usually always under consideration for some ideal location somewhere in the world. These proposed facilities require many years of planning and construction before they can be put into operation and they are not built upon casual speculative decisions.

Canadian lead bullion smelter capacity increased from 190,000 short tons in 1960 to 244,000 short tons in 1967 while production rose from 159,000 tons to nearly 200,000 tons. Slab zinc smelter capacity increased from 287,000 tons in 1960 to 510,000 tons in 1967 while production rose from 261,000 tons to nearly 380,000 tons. The production trends suggest the possibility that another 100,000 tons of lead smelting capacity and 150,000 tons of zinc smelting capacity may be considered in Canada within the next 10 years.

The Yukon, with its large ore reserves of lead and zinc ores, is a suitable candidate as the next smelter location in Canada provided that various deficiencies are overcome.

These deficiencies relate to the availability of suitable carbonaceous reductants, cheap electric power and freight rates, and a rail system linking the smelter with a tidewater port. Without prior assurances and federal assistance on a massive scale, these deficiencies stand little chance of rapid improvement.

Another possibility for secondary processing is related to the iron ore mining industry and the production of pellets and pre-reduced iron ore sinter. This possibility, however, is more difficult to achieve in the Yukon because the inherent disadvantages are more critical for iron ore than for lead-zinc. Iron ore is a low priced commodity with a low profit margin that cannot tolerate abnormal costs, except perhaps in the case of some natural high grade ores. Successful mining operations; are usually very large scale and highly efficient ones producing between 5 to 10 million tons of commercially acceptable products annually. These require large amounts of capital and reasonable access to ports capable of handling bulk cargos and berthing large ocean carriers. The iron ore reserves in the Yukon are immense low grade deposits that rank among the largest known to occur anywhere in the world. Their main problems pertain to (i) access, as a general rule, (ii) concentration and pelletizing, and (iii) quality, such as phosphorus contamination in the case of the Crest deposit. The quality aspect of the Crest ore can be overcome by concentration and pre-reduction techniques according to research work which demonstrated that the phosophorus content in the metallized product can be reduced to acceptable commercial level. This feat, however, can be achieved commercially only if a suitable and cheap reductant is locally available. Coal occurrences have been reported nearby; unfortunately, very little information is available on their quality and reserves, and they should be explored as expeditiously as possible for the sake of enhancing the prospects of an iron ore mining industry. The quality problem does not apply to the iron formation being developed by Selwyn Exploration Ltd. near Clinton Creek but considerable exploration and metallurgical research must be undertaken to support the feasibility of mining operations - this deposit can be a strong contender for iron ore mining in the Yukon.

A review of the Labrador-Quebec iron ore developments indicated that they were under consideration for some 15 years before production commenced in 1952. One should

similarly expect to look into the distant future to justify an iron ore venture in the Yukon. It would be unreasonable to expect such a development without participation by some major steel producers in the world. The evolvement of a steel-making complex in the Yukon is unlikely at this point in time because the present trends to locate such facilities in the large steel consuming centres. The provision of reliable reserves to supply iron ore for such steel plants, however, is a long term consideration for which the Yukon can qualify, provided its environmental deficiencies are overcome. By the same token the long range planning process should span a period of 25 to 50 years, rather than a shorter one, if it is to be an effective guide to mineral development in the North. The corrective measures for attracting an iron ore industry to the Yukon could take some 10 to 15 years to implement and an iron ore industry is unlikely there before 1985. This fact, however, should not detract attention from the objective which should be pursued energetically.

Problems in Perspective

The points of view of at least seven groups of people have a bearing on the level of activities and development of the Yukon. These are:

1- Federal Government
2- Local Government
3- Mining Population
4- Service Industries
5- Prospectors
6- Promoters-Entrepreneurs
7- Mining Companies.

1. Federal Government

Due to its responsibility for the Yukon, the Federal Government is faced with many problems that are somewhat different from those encountered in the rest of the country. The population is very small in the Yukon, but basic services must be provided by the Government to this community as they are provided elsewhere. These services are understandably costly because of the distances that must be linked. The costs of administration and the capital needs to provide basic facilities are unusually high on a per capital as well as on a unit cost basis. The problem faced by the Government is to ascertain

a minimum level of support that it is prepared to provide under any conditions. The Federal Government's problem and obligations can be relieved in part by striving for the creation of a self-supporting economy in the Yukon. This is impossible to achieve without a drastic increase in the economic potential through industrialization and new employment. The mining industry appears to offer excellent opportunities for such industrialization in the Yukon.

There is a suspicion that present cost-benefit studies merely point to the justification of pumping public funds to areas which private industry has already commenced to develop. The present criteria appear to prevent justification of high-risk undertakings such as remote airfields and development roads in presently inaccessible and unexplored areas. The current approach to such studies should be reviewed because it seems to be a narrow one with a short term outlook that ignores the broader multiplier effect that success can bring upon the total Canadian economy.

2. Local Government

With only 15, 000 people presently in the Yukon Territory of some 200, 000 sq. miles, the population base is too small for self-sufficiency. The local government cannot improve its economic base without a massive infussion of people and capital - the mining industry appears to be the most likely one to permit this. The mining industry however, must find deposits with ample profit potential before it can be stimulated to develop mines. The imposition of taxes, such as the 11% Diesel Fuel Tax, on diesel fuel used in off-highway equipment tends to discriminate against the mining industry and causes hardships which must undoubtedly work against the best long term interests of the Territory.

3. Mining Population

Mining communities within the Yukon itself, and in relation to other mining districts in Canada are isolated, and long distances prevail between them. The miners' cost of living is high and must be met by wage premiums and other considerations. The isolated nature means that recreational facilities must be provided to prevent possible boredom and disinterest in the region. The miners' families face education problems that tend to separate the families from their children at early high school ages. The scope of accommodations and range of commodities available in the Yukon communities are

very limited, and the small market potential at present results in very high-priced goods.

As a result of these circumstances it appears that special income tax incentives may be warranted not only for the mining companies, but also for the miners, skilled technicians, administration staff and prpfessional personnel needed to operate mines in the Yukon. The trend towards mechnization will result in a need for increased skills among the available population. The presently small population suggests that large numbers of skilled workers will have to be imported to meet the demands for personnel required by an accelerated development program. The ability to attract large numbers of skilled people to the Yukon will be impaired by the general shortage of such personnel in most mining districts in Canada. Special features must be devised to overcome this problem which could be the most serious one facing the Yukon. Some of these features could be the creation of a Federal agency to provide rental housing, and the gradual conversion of the labour force from a transient one to a permanent one. The creation of job opportunities for women in the mining areas and the importation of mature females for these jobs might also be considered as a means of improving general conditions in the Territory.

4. Service Industries

The service industry operates primarily from Vancouver and Edmonton because resident facilities are unjustifiable under present conditions in the Yukon. The cost of maintaining the supply lines, inventories, and services is an added burden creating extra costs that are passed onto the mine operators. Little improvement is possible in the level of locally available services until large scale industrialization occurs in the region.

5. Prospectors

The prospector faces the normal difficulties of climate and physiography. He further faces costly transportation problems because access roads are scarce, navigable rivers are few, and because conventional small-float aircraft are impractical in many of the areas which are of mineralogical interest. Furthermore, the working of interesting showings

requires the haulage of heavy equipment and supplies through difficult terrain - all of this consumes extra time, effort and money. In general, the inaccessibility of the region, the absence of detailed geological maps, and high-cost transportation systems are discouraging factors that prevent his emphasis on low grade deposits that would be commercial elsewhere. The level of assistance available to prospectors in the form of grants would hardly compensate for the extra inconveniences he now faces in the Yukon. Measures designed to lower the prospector's operating costs may be just as effective as increased subsidies to him.

6. Promoters-Entrepreneurs

The centre of financial support for new mining ventures at the exploratory stage is largely in Vancouver and Toronto. Those with the financial resources are interested in high risk situations that offer high pay-off possibilities. Under present conditions the Yukon is a high risk area because of its remoteness and internal access problems. The required return on investment expected by these people for high risk mining ventures is not usually available in the Yukon except in situations that involve high grade ore deposits. Consequently, the general level of interest towards the Yukon among promoters-entrepreneurs is less than would apply elsewhere in favourably developed mineral districts. The extra costs required for exploration activities are factors that work against the Yukon because the same amount of dollars could cover more ground somewhere else in the country.

These people play an important role in the development of the mineral industry by grub-staking prospectors and by financing prospect developments in the very early stages in virgin territory. Their participation in the Yukon mineral industry is vital and should be encouraged by improving the adverse conditions.

7. Mining Companies

The desire for long term positions in mineral resources, and the ability to make an adequate level of profit for their shareholders are prime considerations for mining companies. Higher compensation levels and fringe benefits are required to attract managers, technicians, and skilled operators to remote areas such as the Yukon, and this can

affect profitability in small ventures. The high extra production costs that must be borne by present mining companies are noteworthy factors that prevent such companies from showing more interest in the Yukon. The inherently high cost levels must be reduced if mineral development is to be accelerated in the future.

LEGEND

LEAD SMELTER	×
ZINC	●
COPPER	□

MINERAL INDUSTRY STUDY
YUKON TERRITORY

SMELTER LOCATIONS IN THE PACIFIC REGION (Lead, Zinc, Copper only)

RESOURCES ENGINEERING OF CANADA LIMITED
CONSULTING ENGINEERS TORONTO, CANADA

		APPROVED
JMS	WBM	GCM

DATE	SCALE	
JULY 1968		EXHIBIT 9-1

CHAPTER 10

GROWTH POTENTIAL OF MINERAL INDUSTRY

The growth potential of the Yukon mineral industry is dependent to a large extent upon the measures taken to alleviate those conditions which contribute to the present high costs. This potential is most easily described in terms of the value of mineral production as reported by the Dominion Bureau of Statistics. At least three cases or possible circumstances are foreseeable and each would result in a different level of projected mining activity as noted in Exhibit 10-1; these cases are:

Case 1- A continuation of the present high cost conditions into the foresseable future. This assumes that only the presently commercial type ores will continue to be mined and that new discoveries of such ores will be made in the future.

Case 2- Correction of the high cost conditions as expeditiously as possible to permit substantial long term improvements. This assumes the following:

i) construction of a standard gauge railroad in the Yukon and access to an ocean port by 1980 with reduced freight rates.

ii) low cost electric power production at Carmacks from local coal, and reduced rates for electric power.

iii) an ample population, and permanent skilled labour available throughout the Territory.

iv) a well developed infrastructure financed by the governments.

v) a continuation of the mining of presently commercial types of ores and the expectation that further new discoveries of such ores will be made.

vi) new mining developments will include the mining of presently marginal types of ores, and the expectation that further new discoveries of such lower grade ores will be made.

vii) mining of iron ore to commence in 1985, and the availability of low cost fuel and reductants for pelletizing and pre-reduction.

viii) a favourable investment climate will continue in the Yukon indefinitely as a result of attractive development incentives and taxation rates.

Case 3- An intermediary position between Case 1 and Case 2 under the assumption that some of the present high cost conditions are only moderately improved.

Each case is reviewed briefly in the following discussions; the projected annual production potential is illustrated in Exhibit 10-1.

Case 1 Projections to 1995

Under Case 1 assumptions the value of mineral production in the Yukon will probably increase to $50.0 million in 1970, and to $85.0 million in 1975 as a result of the new mines of Anvil, Cassiar, and New Imperial. The production mix in 1975 is likely to be the following:

Mine Product	Quantity	Value
Lead concentrates	135,000 tons	$26.0 million
Zinc concentrates	240,000 tons	36.0 million
Asbestos bales	60,000 tons	10.0 million
Copper concentrates	25,000 tons	6.2 million
Gold	20,000 oz.	0.8 million
Silver	3,000,000 oz.	6.0 million
	Total	$85.0 million

New production beyond 1975 is likely to grow at 3-1/2% per annum and will result from expansions at the present mines and from occassional new high grade ore discoveries. Production values are likely to reach $140.0 million in 1985 and $200.0 million in 1995. A modest growth is projected under present high cost conditions which favour the development of high grade deposits that can withstand temporary adverse conditions.

Case 2 Projections to 1995

Under Case 2 assumptions, the value of mineral production in the Yukon will probably increase to $50.0 million in 1970, and to $85.0 million in 1975 as a result of the new mines of Anvil, Cassiar, and New Imperial. The projected production values until 1975 are the same as in Case 1 because the benefits of the corrective measures are not likely to be experienced until after 1975; it is therefore unrealistic to expect the mining of presently marginal type ore deposits before then.

Beyond 1975 a compounded growth rate of 11% per annum is probable until 1985, with production value then at $240 million arising from the presently commercial and presently marginal type ore deposits. Growth prospects beyond 1985 for these two categories of ores will probably be in the order of 3-1/2% per annum, with production value rising to $300 million in 1995.

Iron ore mining in the Yukon could not commence before 1985 because of the enormous amount of time needed for general planning and construction of the railroad, ocean port, townsites and mining plants. With iron ore developments in progress the growth rate beyond 1985 for total mineral production would probably be at 7-1/2% per year until 1995 when production values could be $480 million.

Under the assumptions of Case 2, the production mix in 1995 is estimated to be the following:

Main Products	Quantity	Value
Lead concentrates	402,000 tons	$ 77.4m
Zinc concentrates	726,000 tons	106.5m
Asbestos bales	178,000 tons	26.7m
Copper concentrates	75,000 tons	18.9m
Pelletized iron ore concentrates	12,000,000 tons	180.0m
Molybdenum concentrates	10,000 tons	17.5m
Copper-Nickel concentrates	40,000 tons	16.0m
Tungsten concentrates	3,000 tons	6.0m
Gold	40,000 oz.	1.6m
Silver	8,700,000 oz.	17.4m
Coal	2,000,000 tons	12.0m
	Total	$480.0m

This projected production value represent the optimum mineral potential of the Yukon and is based on current metal prices in terms of 1968 dollars. It is based on the further assumption that many new commercial ore deposits will be found which are not yet known to exist in the Yukon, namely those containing molybdenum, porphyry copper, and nickel. This mineral production would represent the mining of some 42,300,000 tons of ore at about 21 mines. The number of employees directly on the mines' payrolls would be in the order of 8,250. Some 354,000 KW of electric power capacity would be necessary for the mines alone.

The attainment of this level of production by 1995 would require exploration and capital expenditures of nearly one billion dollars by private industry over the next twenty years; a similar amount of public funds over the same period of time would probably be required for roads, railroads, port facilities, basic utilities, municipal services, townsites and other related public needs. Attainment of this optimum annual mineral production potential would require the close coordination of development activities by Government and private industry. A prior expression of intent by the Government to provide the basic infrastructure would probably accelerate the rate at which private industry would follow with mining developments in the Yukon Territory.

Case 3 Projections to 1995

Under Case 3 assumptions there is little likelihood of significant cost improvements for the mining industry. Production values would probably approximate those for Case 1, rising to about $200.0 millions annually in 1995.

Petroleum and Natural Gas

Major discoveries of oil and gas were reported recently in Northern Alaska on the Arctic slope at Prudhoe Bay about 200 miles west of the Yukon border. The discoveries were made in a thick widespread sedimentary basin stretching some 700 miles eastward from Point Barrow, Alaska, to Liverpool Bay in the Northwest Territories; the basin also includes the Arctic Plateau and Plain, Yukon Plateau, Peel Plateau, and Eagle Plain in the northern Yukon. This major discovery will probably accelerate the pace of Northern exploration activity which is already gaining considerable momentum. The rising level of exploration activity, coupled with a high success ratio that has been encountered in the small number of wells drilled to date, leads to the observation that this sedimentary basin could become an important oil and gas producing area in the next ten to twenty years.

The problems of competitively marketing crude oil from this presently remote area could be solved only by proving up large volumes of reserves and developing production facilities to the extent necessary to justify large capacity pipelines to southern Alaska for subsequent tanker shipment to the U. S. West Coast markets, or directly to the U. S. Midwest. Production capacities in the order of 1, 000, 000 to 1, 500, 000 barrels per day, and pipelines exceeding 36" in diameter would therefore be required to effect significant production and transportation economies. With the overall demand growth in the United States offering a potential for 1. 5 to 2 million barrels per day in additional requirements by 1980, it is more likely to expect Alaskan production to find a market in the U. S. rather than in the Far East where Middle East crude can now be laid down for about $2. 00 per barrel. The movement of such large volumes of crude from Arctic regions over long distances would not be unique and formidable undertakings in the world considering the achievements made in this field by scientists and engineers in the U. S. S. R.

Considering the small size of the potential industrial-energy market in the Yukon, in relation to the scale of production required to achieve competitive marketing of Arctic Slope petroleum in North America, it is most unlikely that new oil refinery operations would be justified near the source of production to competitively provide refined petroleum products (in spite

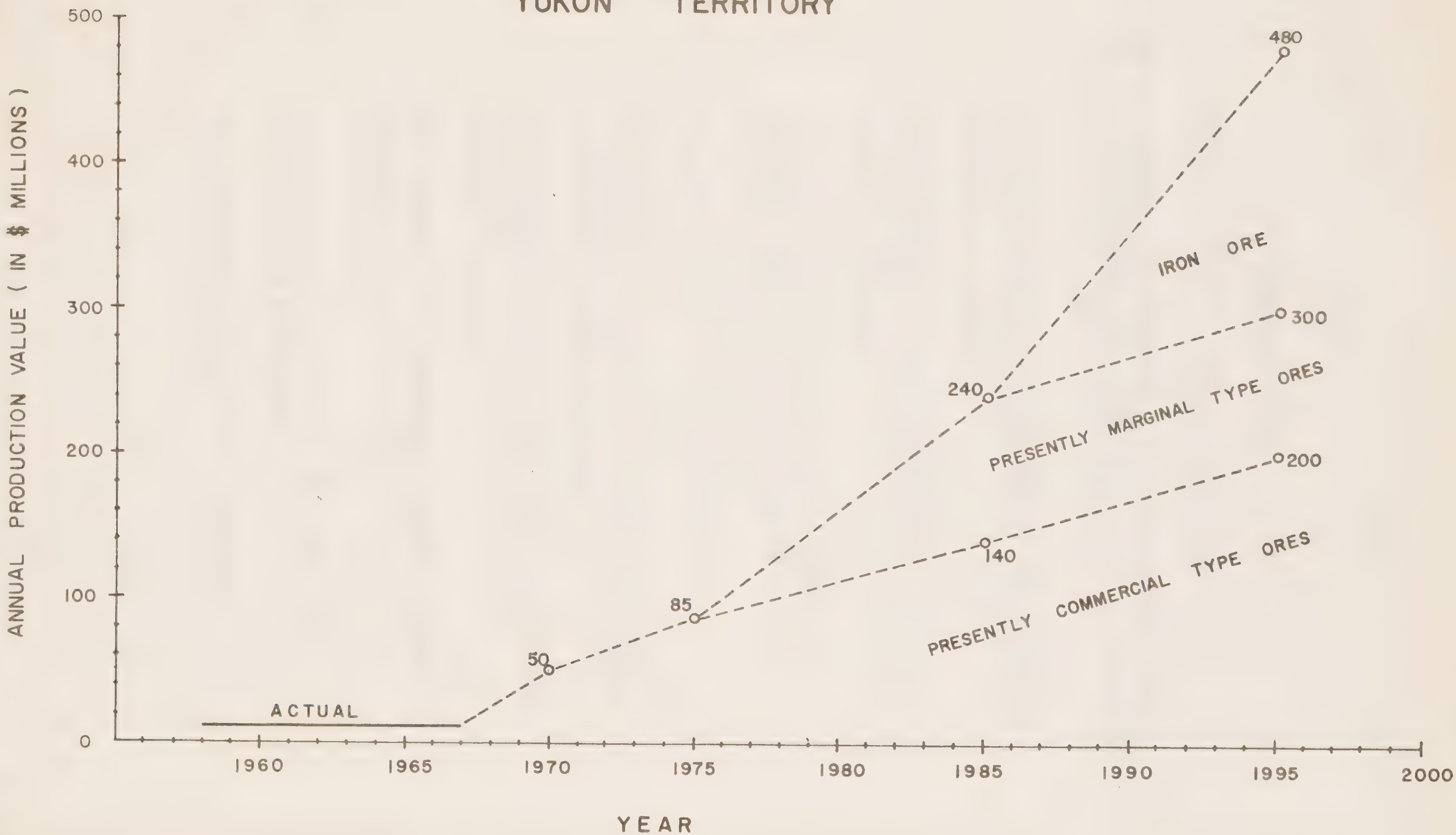
of their current high prices) for the Yukon market. On the other hand, natural gas produced in the Arctic Plain could conceivably be an important industrial fuel in the Yukon, providing a competitive alternative fuel to local coal for thermal electric power generation. A 300 MW thermal plant would require approximately 75 million cubic feet of natural gas per day and it could produce power for 5 to 6 mills per KWH with gas delivered to it at 20¢ per thousand cubic feet. An iron ore pelletizing operating would require about 3.5 gallons of fuel oil per ton of pellets produced; consequently a 10 million tons per year plant would require one million barrels of oil per year or approximately 3,000 barrels per day. Alternatively, natural gas requirements for the above plant would approach 15,000,000 cubic feet per day. Although such an iron ore operation is a large one by today's standards, the fuel requirements for it are small in relation to the amount of fuel that would be available from an economically sized unit.

The overall oil and gas production potential of the Yukon Territory, as measured by the area overlain by favourable sediments, is small in relation to that of the neighbouring areas. The total area underlain by such sediments in the Yukon is only 43,000 square miles versus some 555,000 square miles in the Northwest Territories and Arctic Islands combined. In addition, the mainland exploration acreage held under oil and gas permits in the Yukon is small and has been relatively constant compared to the large and growing area of permit holdings in the Northwest Territories and Arctic Islands. Because of its location, a Yukon based petroleum industry could also face more difficult marketing and transportation problems than would be expected in either Alaska or the Northwest Territories. Given the industry's present greater interest and activities in these adjacent areas, it is likely that the latent potential for oil and gas production in the Yukon will not be fully explored or developed within the next ten to twenty years. Insofar as petroleum and natural gas exploration activity are interrelated, the full exploration of latent natural gas potential in the Yukon is also likely to lag behind some presently more promising areas of the U.S. and Canadian North.

Significantly increased exploration activity could be expected in the Yukon only if enormous reserves are proven in the neighbouring areas within the next 10 years, and if delivery facilities are built to handle large volumes of northern oil and gas via pipeline and ocean tankers to distant markets.

Under the assumption that favourable developments will occur throughout this Arctic sedimentary basin, it is reasonable to project some oil production from the Yukon in the distant future. Production could commence in 1990 and build up gradually to about 20 million barrels per year by 1995. This production would be valued at around $1. 50 per barrel in today's currency. Oil production could therefore add $30 million dollars to the projected annual mineral production potential of the Yukon by 1995, increasing the total annual potential to $510 million.

PROJECTED ANNUAL PRODUCTION POTENTIAL
1968 — 1995
YUKON TERRITORY



JULY 1968

EXHIBIT 10—1

EXHIBIT 10-1A

GENERAL ASSUMPTIONS FOR PROJECTIONS

(The assumptions and projections herein are based solely on the opinions and judgements of the authors from interviews, literature research, and field investigations.)

1- Improved conditions can be expected by the mining industry, - namely a railroad, low cost power, and favourable incentives.

2- Mine production values represent the contained metals in concentrates at current metal prices in terms of 1968 dollars.

3- The Mine Index Numbers do not describe the identity numbers of the major and inferred ore deposits referred to in Chapter 6.

4- No smelting facilities are included.

5- Supporting Service Industry requirements will be equal numerically to the number of employees required for the projected mines.

6- Exploration expenditures from 1970 to 1995 would approximate $10 million annually under the improved conditions.

7- No revenues from commercial natural gas and oil production are contemplated during this period.

8- Local Carmacks coal will be the source of electric power generation.

9- New discoveries will be made, replacing depleted ore reserves.

EXHIBIT 10-1B

GENERAL ASSUMPTIONS FOR PROJECTIONS

Projected Mine Index Number	General Area Location	Expected Mine Products	Projected Year of First Production
1	Dawson	Placer Gold	C*
2	Mayo	Placer Gold	C*
3	Mayo	Silver-Lead-Zinc Conc.	C*
4	Whitehorse	Copper-Gold Conc.	C*
5	Clinton Cr.	Asbestos Bales	C*
6	Ross River	Lead-Zinc-Silver Conc.	1969-P**
7	Clinton Cr.	Asbestos Bales	1973
8	Carmacks	Coal	1976
9	Mayo	Silver-Lead-Zinc Conc.	1977
10	Whitehorse	Copper-Gold Conc.	1978
11	Ross River	Lead-Zinc-Silver Conc.	1980
12	Burwash	Nickel-Copper Conc.	1981
13	Clinton Cr.	Asbestos	1981
14	Wolf Lake	Molybdenum Conc.	1982
15	Macmillan P.	Tungsten Conc.	1982
16	Carmacks	Coal	1983
17	Frances L.	Lead-Zinc-Silver Conc.	1985
18	Snake R.	Pelletized Iron Ore Conc.	1986
19	Clinton Cr.	Asbestos	1988
20	Clinton Cr.	Pelletized Iron Ore Conc.	1990
21	Watson L.	Copper-Gold Conc.	1992

*C - Current Producer
**P - Plant under Construction

EXHIBIT 10-1C

GENERAL ASSUMPTIONS FOR PROJECTIONS

Projected Mine Index Number	Expected Annual Mine Projection at Full Capacity	Metal Content in Concentrate	Current Unit Value $ Canadian
			$
1	20,000 oz. gold		38.00/oz.
2	10,000 oz. gold		38.00/oz.
3	6,000 tons lead concentrate	69% Pb	0.14/lb.
	3,000 tons zinc concentrate	54% Zn	0.135/lb.
	2,500,000 oz. silver in above concentrates		2.00/oz.
4	25,000 tons copper concentrate	25% Cu	0.50/lb.
5	60,000 tons asbestos bales		150.00/ton
6	130,000 tons lead concentrate	69% Pb	0.14/lb.
	240,000 tons zinc concentrate	54% Zn	0.135/lb.
	1,200,000 oz. silver in above concentrates		2.00/oz.
7	30,000 tons asbestos bales		150.00/ton
8	1,000,000 tons coal		6.00/ton
9	6,000 tons lead concentrate	70% Pb	0.14/lb.
	3,000 tons zinc concentrate	60% Zn	0.135/lb.
	2,500,000 oz. silver in above concentrates		2.00/oz.
10	25,000 tons copper concentrate	25% Cu	0.50/lb.
11	150,000 tons lead concentrate	69% Pb	0.141/lb.
	290,000 tons zinc concentrate	54% Zn	0.135/lb.
	1,500,000 oz. silver in above concentrates		2.00/oz.
12	40,000 tons nickel-copper concentrates	15% Ni	1.00/lb.
		10% Cu	0.50/lb.
13	60,000 tons asbestos bales		150.00/ton
14	10,000 tons molybdenum concentrates	54% Mo	1.62/lb.
15	3,000 tons tungsten concentrates	65% WO_3	1.50/lb.
16	1,000,000 tons coal		6.00/ton
17	110,000 tons lead concentrate	69% Pb	0.14/lb.
	190,000 tons zinc concentrate	54% Zn	0.135/lb.
	1,000,000 oz. silver in above concentrates		2.00/oz.
18	9,000,000 tons pelletized iron ore conc.	65% Fe, 0.5% P	14.75/ton
19	28,000 tons asbestos bales		150.00/ton
20	3,000,000 tons pelletized iron ore conc.	65% Fe	16.00/ton
21	25,000 tons copper concentrate	25% Cu	0.50/lb.
	10,000 oz. gold in above concentrates		38.00/oz.

EXHIBIT 10-1C

GENERAL ASSUMPTIONS FOR PROJECTIONS

Projected Mine Index Number	Expected Annual Mine Projection at Full Capacity	Metal Content in Concentrate	Current Unit Value $ Canadian $
1	20,000 oz. gold		38.00/oz.
2	10,000 oz. gold		38.00/oz.
3	6,000 tons lead concentrate	69% Pb	0.14/lb.
	3,000 tons zinc concentrate	54% Zn	0.135/lb.
	2,500,000 oz. silver in above concentrates		2.00/oz.
4	25,000 tons copper concentrate	25% Cu	0.50/lb.
5	60,000 tons asbestos bales		150.00/ton
6	130,000 tons lead concentrate	69% Pb	0.14/lb.
	240,000 tons zinc concentrate	54% Zn	0.135/lb.
	1,200,000 oz. silver in above concentrates		2.00/oz.
7	30,000 tons asbestos bales		150.00/ton
8	1,000,000 tons coal		6.00/ton
9	6,000 tons lead concentrate	70% Pb	0.14/lb.
	3,000 tons zinc concentrate	60% Zn	0.135/lb.
	2,500,000 oz. silver in above concentrates		2.00/oz.
10	25,000 tons copper concentrate	25% Cu	0.50/lb.
11	150,000 tons lead concentrate	69% Pb	0.141/lb.
	290,000 tons zinc concentrate	54% Zn	0.135/lb.
	1,500,000 oz. silver in above concentrates		2.00/oz.
12	40,000 tons nickel-copper concentrates	15% Ni	1.00/lb.
		10% Cu	0.50/lb.
13	60,000 tons asbestos bales		150.00/ton
14	10,000 tons molybdenum concentrates	54% Mo	1.62/lb.
15	3,000 tons tungsten concentrates	65% WO_3	1.50/lb.
16	1,000,000 tons coal		6.00/ton
17	110,000 tons lead concentrate	69% Pb	0.14/lb.
	190,000 tons zinc concentrate	54% Zn	0.135/lb.
	1,000,000 oz. silver in above concentrates		2.00/oz.
18	9,000,000 tons pelletized iron ore conc.	65% Fe, 0.5% P	14.75/ton
19	28,000 tons asbestos bales		150.00/ton
20	3,000,000 tons pelletized iron ore conc.	65% Fe	16.00/ton
21	25,000 tons copper concentrate	25% Cu	0.50/lb.
	10,000 oz. gold in above concentrates		38.00/oz.

EXHIBIT 10-1D

GENERAL ASSUMPTIONS FOR PROJECTIONS

Mine Index Number	Estimated Annual Mining Capacity in Tons of Ore	Number of Employees	Approximate Capital Required $ Millions	Approximate Electric Power Capacity Required KW
1	1,000,000	300	$ 2.0	5,000
2	500,000	150	1.0	2,000
3	100,000	300	5.0	5,000
4	700,000	200	20.0	10,000
5	750,000	300	25.0	10,000
6	1,500,000	300	60.0	10,000
7	375,000	100	10.0	5,000
8	1,200,000	300	15.0	10,000
9	100,000	300	5.0	5,000
10	700,000	200	20.0	10,000
11	1,800,000	400	75.0	12,000
12	350,000	400	20.0	7,000
13	750,000	300	25.0	10,000
14	2,750,000	700	50.0	25,000
15	1,250,000	400	15.0	15,000
16	1,200,000	300	10.0	10,000
17	1,200,000	200	50.0	8,000
18	18,000,000	2,000	300.0	120,000
19	375,000	100	10.0	5,000
20	7,000,000	800	90.0	50,000
21	700,000	200	20.0	10,000
Total	42,300,000	8,250	$828.0	354,000

EXHIBIT 10-1E

GENERAL ASSUMPTIONS FOR PROJECTIONS

Mine Index Number	Approximate Annual Production Value at Full Capacity	Probable First Year of Full Capacity Operations
1	$ 800,000	Current producer
2	400,000	Current producer
3	6,700,000	Current producer
4	6,300,000	1969
5	9,000,000	1970
6	62,400,000	1972
7	4,500,000	1976
8	6,000,000	1979
9	6,700,000	1980
10	6,300,000	1981
11	74,500,000	1983
12	16,000,000	1984
13	9,000,000	1984
14	17,500,000	1985
15	6,000,000	1985
16	6,000,000	1986
17	51,000,000	1988
18	148,000,000	1988
19	4,200,000	1991
20	32,000,000	1993
21	6,700,000	1995
Total	$480,000,000	

Note:
a) Estimated production value in 1970 is $ 50,000,000
b) Estimated production value in 1975 is $ 85,000,000
c) Estimated production value in 1985 is $240,000,000
d) Estimated production value in 1995 is $480,000,000

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